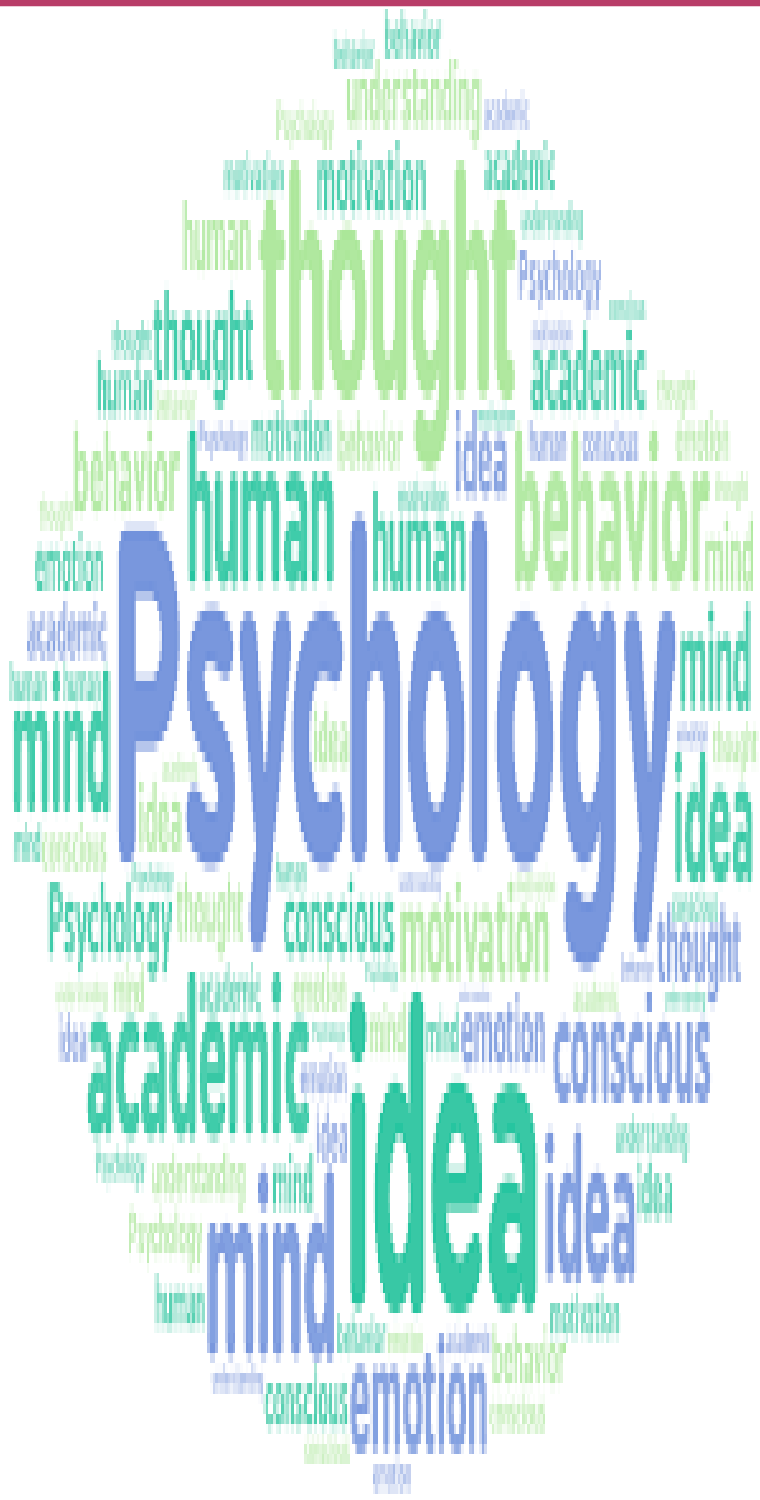
# Research Methodology and Statistics

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# What is Research: Meaning, Purpose, and Dimensions, Research problems, Variables and Operational Definitions, Hypothesis, Sampling, Ethics in conducting and reporting research?

**Research: Meaning, Purpose, and Dimensions, Research problems, Variables and Operational Definitions, Hypothesis, Sampling ,Ethics in conducting and reporting research**

## The Research Meaning of Psychology

Psychologists try to answer these questions, develop the principles to explain them, and use those principles to solve various problems. The range of application of psychology is very wide. A cognitive psychologist may like to know the causes of forgetting. An organisational psychologist may try to find out nature of resistance among the employees to introduction of new performance appraisal system. A health psychologist may like to examine the relationship between smoking behaviour and coronary heart disease.

While evaluating major areas of psychological researches, a psychologist uses the principles and practices of scientific methods. This unit attempts to acquaint you with nature and relevance of psychological research. This is followed by the process of psychological research within the context of discovery and context of justification as well as distinctive goal of psychological researches.

## OBJECTIVES

After reading this unit, you will be able to: Describe the research process in terms of how to conduct sound research and

λ how to evaluate critically the research of others; Understand why people behave as they do;

λ Discuss how to maintain objectivity and minimize the research bias in psychology

λ research; Tell others the role of theory, hypothesis and paradigm in psychological research;

λ Discuss the primary objectives and goals of psychological research;

λ Identify some of the problems one encounters in trying to do reliable and valid

## NATURE OF PSYCHOLOGICAL RESEARCH

Importance and relevance of psychological research is well recogni sed almost in every sphere of human life. Notable progress has been reported in the field of organisational behaviour, applied aspects of human being, medical sciences and education, through application of psychological research findings. Empirical and theoretical researches in psychology are taking place in various fields, such as learning, motivation, perception, concept learning and memory and so on.

In the quest of psychological facts, laws and theories, psychologists have found research studies very helpful in gauging human and animal behaviour. Psychological research attempts to understand why people and animals behave as they do. Psychologists usually define behaviour as overt activities, such as eating, recalling stories, and so on. What about covert psychological processes, such as

thinking and feeling? Although thoughts and feelings are not directly observable, they influence such aspects of behaviour as reaction time and blood pressure, which are often used to measure these covert processes.

Practical gains of psychological research are many, yet include discoveries such as improved methods of treating psychologically disordered people, better designs of vehicles to make them easier and safe to use, and new ways of enhancing the performance and happiness of workers. Before we examine what researchers have found in the major areas of psychology, we need to identify the ways psychologists gather data about behaviour and mental processes.

You may be a daily consumer of mass media reports on research findings. Some of these are valuable, some are worthless, and others are confusing and misleading. You will become a wiser consumer of research-based conclusions as you develop your understanding of how psychological research is conducted and why the scientific view of knowledge dictates such methods. Let us turn now how psychologists know what they know.

Recall that psychology is the scientific study of behaviour and mental functioning of individuals. It is scientific because it uses the principles and practices of the scientific method.

**Role of Theories, Hypotheses and Paradigms in Psychological Research**

Psychological research focuses on four sets of concerns:

i) the stimulus events that cause a particular response to start, stop, or change in quality of quantity;

ii) the structure of behaviour that links certain actions in predictable, orderly ways to other actions;

iii) the relationships between internal psychological processes or psychological mechanisms and observable behaviour patterns; and

iv) the consequences that behaviour has on the individual's social and physical environment. Researchers begin with the assumption of determinism, the idea that all events (physical, mental and behavioural) result from specific causal factors.

Researchers also assume that behaviour and mental processes follow set patterns of relationships that can be discovered and revealed through research. Psychological theories, in general, attempt to understand how brain, mind, behaviour, and environment function and how they may be related.

Any particular theory focuses on a more specific aspect of this broad conception, using a body of interrelated principles to explain or predict some psychological phenomenon. The value of a theory is often measured in terms of the new ideas, or hypotheses, that can be derived from it and tested.

A hypothesis is a tentative and testable explanation of the relationship between two or more events or variables. A variable is any factor that changes, or varies, in size or quality. To illustrate this mood may be a variable, since people's moods may vary from one situation to another. Test performance is another variable, since a person's score may vary from one test to the next.

A hypothesis is a testable explanation of the relationship between variables, it is a tentative proposition based on observations, or it could be a hunch about how ideas go together. An instructor, for example, may have a hypothesis about how varying teaching

techniques will cause changes in students' test scores. Thus, instructor may have formed this hypothesis by observing students; idea about better teaching techniques is also generated from research in educational psychology.

**Research Biases**

One of the challenges, while doing research is to remain objective and free from biases. Most of your ideas and beliefs are probably linked with certain bias because they are influenced by your opinions or values. A variety of biases have been found to distort people's impressions of collected data. External influences such as one's culture or the media can influence people to accept a particular world view.

Personal bias distorts estimating or evaluating processes as a result of personal beliefs, attributes, or past experiences. Observer bias operates when one's biases act as "filters" through which some events are noticed or seen as meaningful while others are not. It must be kept in mind that researchers themselves were raised in certain cultures and societies. They also might have been exposed to certain gender role expectations. These background factors can all affect the way that researchers observe and interpret events in their lives.

Expectancy bias can affect observations of behaviour by triggering reactions to the events being observed. Researchers sometimes expect to find specific outcomes, and being only human, they may see what they expect to see rather than remain objective. Unfortunately, if one is not alert to the possibility of expectancy bias, it may seem as though the observed events are being "discovered" instead of created by the observer's expectations.

## Purpose and Dimensions of Psychology

### GOALS AND OBJECTIVES OF PSYCHOLOGICAL RESEARCH

Every science has goals. In physics, the goals are concerned with learning how the physical world works. In astronomy, the goals are to chart the universe and understand both how it came to be and what it is becoming.

The goals of psychologist conducting basic research are to describe, explain, and predict and control behaviour. The applied psychologist has a fifth goal also, that is application of psychological techniques and principles to improve the quality of human life.

Most applied psychologist are able to conduct their own basic research, scientifically studying particular problem in order to solve them. The process of accomplishing one goal and moving on to the next is ideally a natural , flowing , experience, energized, by the psychologist's interest in the question being studied.

The first step in understanding anything is to give it a name. Description involves observing a behaviour and noting everything about it, as for example, what is happening, where it happens, to whom it happens, and under what circumstances it happens.

**Explanation:**

To find out why the girl is not behaving properly, the teacher would most likely ask the school counselor to administer some tests. Her parents might be asked to take her to a pediatrician to make sure that there is no physical illness, such as an allergy. They might also take here to a psychologist to be assessed. In other words, the teacher and others are looking for an explanation for the young girl's

behaviour. Finding explanation for behaviour is a very important step in the process of forming theories of behaviour. A theory is a general explanation of a set of observations or facts.

The goal of description provides the observations, and the goal of explanation helps to build the theory. If all the tests seem to indicate that the young girl has a learning problem, such as dyslexia (an inability to read at expected levels for a particular age and degree of intelligence), the next step would be trying to predict what is likely to happen if the situation stays the same.

**Prediction:**

When Will it Happen Again? Determining what will happen in the future is a prediction. In the example, the psychologist or counselor would predict (based on previous research into similar situations), that this little girl will probably continue to do poorly in her schoolwork and may never to be able to reach her full learning potential.

Clearly, something needs to be done to change this prediction, and that is the point of the last of the four goals of psychology: changing or modifying behaviour.

**Control :**

How can it be Changed ? Control, or the modification of some behaviour, has been somewhat controversial in the past. Some people hear the word control and think it is brainwashing, but that is not the focus of this goal. The goal is to change a behaviour from an undesirable one (such as failing in school) to a desirable one (such as academic success).

Such efforts also include attempts at improving the quality of life. In the example of the young girl, there are certain learning strategies that can be used to help a child (or an adult) who has dyslexia . She can be helped to improve her reading skills.(Aylward etal,2003;Shaywitz,1996). The psychologist and educators would work together to find a training strategy that works best for this particular girl.

**Application**

Improving the quality of life Psychological research are often conducted to solve various problems faced by the society at different levels such as individual, organisation, or community.

Psychological applications to solve problems in diverse settings, such as in a classroom in a school, or in an industry, or in a hospital, or even in a military establishment, demand professional help.

Applications in the health sector are remarkable. Because of these efforts quality of life becomes a major concern for psychologists. Not all psychological investigations will try to meet all five of these goals. In some cases, the main focus might be on description and prediction, as it would be for a personality theorist who wants to know what people are like (description) and what they might do in certain situation (prediction).

Some psychologists are interested in both description and explanation, as is the case with experimental psychologists who design research to find explanations for observed (described) behaviour. Therapists, of course, would be more interested in control, although the other four goals would be important in getting to that goal.

**dimensions of psychological well-being**

The six dimensions reflected within psychological well-being are as follows:

1. **Self-acceptance**

**This dimension speaks of the acceptance of every aspect of an individual and of one's own past, just as it happened.** This means without falling into a pit of impotence for wanting to modify or intervene in what happened.

Think about whether you accept your body, your emotions and your thoughts. If you do, you'll have a more positive view of yourself. Instead, if you have low self-esteem and struggle to accept who you are, it's possible that due to this dissatisfaction, **you'll feel so overwhelmed that you don't even know where to begin changing those aspects you actually can intervene in.**

2. **Control over your surroundings**

**This dimension refers to the ability to deal with a difficult environment, having the ability to adapt to adverse circumstances.**

If you have a high perception of your **control** over your surroundings, you'll feel capable of influencing your environment and managing complicated situations. Instead, if you have low control over your surroundings, according to the psychological well-being questionnaire, you'll have greater difficulty overcoming the adversities which arise in your day-to-day life.

3. **Positive relationships with others**

**This dimension measures the ability people have to interact with others in an open and sincere way.**

If you're capable of having satisfactory relationships with others, you will promote bonds which will provide you with better emotional quality. **This implies having a greater capacity of empathy and openness towards people.** If you have a lower score on this scale, it's possible you struggle to interact with others. You might have difficulties opening up and trusting others, as well as difficulties maintaining your relationships.

**4. Autonomy**

**This dimension evaluates the independence of people in different aspects of their lives. The sensation of being able to choose and make their own decisions**, of maintaining a personal criteria and personal and **emotional** independence despite others not being in agreement.

A high degree of autonomy implies that you're able to deploy a greater force of resistance against social pressure and your own impulses. **If, instead, you have a low degree of autonomy, you might be letting other people's opinions guide you.** You also might pay attention to what others say or think about you and might let yourself be led by social pressure within your social circle.

**5. Personal growth**

**This dimension measures the ability people have of learning from themselves, being open to new experiences and challenges.**

If you promote your personal growth, it's possible you feel that you're on a continuous journey of learning. You might feel that you

have the ability to learn from what you receive and know that you have the resources needed to improve. **If this whole personal growth thing is not your style, you might feel stuck, bored and demotivated.** You might not really want to develop new lessons and new growth behaviors. Or, you might simply feel incapable of it.

**6. Life purpose**

**This measures the need people have of finding a purpose that will give meaning to their lives.** People need to set clear and acceptable **goals** for themselves. These need to be realistic objectives.

If have a high score in this dimension, it means that you feel your life has meaning. You give meaning to your past, present and future. **If, instead, you score poorly in this dimension, you don't have a clear purpose.** It's possible you feel that your life lacks direction or you might even feel disoriented and lost.

**7. Social support: the best pillar of our well-being**

Social support is a protective factor against various diseases. It's very important how our social relationships are and also how we perceive them to be.

- **People who are emotionally intelligent are more optimistic, have higher self-esteem and have a greater capacity for empathy.** This contributes to the improvement of our psychological well-being. People who know how to identify their emotions feel more satisfied with themselves. Therefore, they feel a greater sense of overall well-being. **Find your passion**

It might be at work, since that's where you spend many hours of your day. And it's best if you spend them doing something that motivates you. But you can also find something you like in a hobby which makes you feel fulfilled. For example, music, a sport or craftsmanship.

- **Don't try to change yourself**

**Accept yourself in the dimensions you cannot change.** Trying to change yourself is going to generate unease and rejection. You will improve your well-being is you give yourself and your own nature a chance. This way, all of the positive things you find will serve to improve your self-esteem, because you will acknowledge it as your own. The same thing will happen with the negative things you find.

- **Surround yourself with people who have a good energy**

Positive relationships, being with people you like and who fulfill you is an **important factor** which directly influences you physical and emotional well-being. **Toxic people will reduce your psychological well-being and add stress to your life.**

## Research problems in Psychology

### Research problems in Psychology

Your thesis in Psychology should **ask and answer a specific question**, rather than broadly discuss a large topic area. Furthermore, your research problem should **suggest one or more subsequent questions** to your readers.

The statement of the research problem should be **precise** and **concise**. It should be coherent enough that you can

readily discuss it with family or friends - and that they will understand it.

It is recommended that you go over the four key parts (**Research Question**, **Hypothesis**, **Evidence**, **Conclusions & Broader Implications**) in an outline **before** you start to write your proposal.

- You may find it easier to write the Research Problem last, after you have already reviewed the literature in the Background of the Problem section, and fleshed out your Research Method
- **This may help you to focus your research problem and keep it concise**

## Nature and Meaning

A scientific inquiry starts when a researcher has already collected some information/ knowledge and that knowledge indicates that there is something we do not know. It may be that we simply do not have enough information to answer a question, or it may be that the knowledge that we have is in such state of distorted form that it cannot be adequately related to the question. Here a problem arises.

The formulation of a problem is especially important, as it guides us in our inquiry. According to Townsend (1953) ‘a problem is a question proposed for solution’. According to Kerlinger (1964) ‘A problem is interrogative sentence of statement that asks: What relation exists between two or more variables’. According to McGuigan (1964) ‘A solvable problem is one that posses a question that can be answered with the use of man’s normal capacities’.

## Characteristics of a Scientific Problem

After analysing above written definitions of a problem statement, it can be said there are certain characteristics of a problem statement:

i) A problem statement is written clearly and unambiguously, usually in question form.

ii) A problem expresses the relationship between two or more than two variables. This kind of problem permits the investigator to manipulate two or more than two variables to examine the effects upon the other variables. For example: Do teacher reinforcement cause improvement in student performance? In this example, one variable is teacher reinforcement and the other variable is student performance. It illustrates the problem found in a scientific study because the problem statement explores the effect of teacher's reinforcements on student performance. The conditions for a problem statement are:

The problem should be testable by empirical methods

λ A problem statement should be solvable

.λ The data of a scientific problem should be quantitative

.λ The variable relating to the problem should be clear and definite

**Ways in which a Problem is Manifested**

A problem is said to exist when we know enough that there is something we do not know really. There are atleast three ways in which a problem is said to be manifested: Gap in knowledge: A problem is manifested when there is a noticeable gap or absence of information. Suppose a community or group intents to provide psychotherapeutic services, two questions arise, viz.,

(i) What kind of psychotherapy they should offer and

(ii) Which one of the different forms of therapeutic methods is most effective for a given type of mental disease. In this example, there exists a noticeable gap in the knowledge, and hence the collection of necessary data and their explanation are needed for filling the gap in knowledge. Contradictory results:

When several investigations done in the same field are not consistent and therefore, at times, contradictory, a problem is to find out a new answer and settle the controversy. Explaining a Fact: Another way in which we become aware of a problem is when we are in possession of a 'fact', and we ask ourselves, "Why is this so ?" When the facts in any field are found in terms of unexplained information, a problem is said to exist.

## The Importance of Formulating a Research Problem

The formulation of a research problem is the first and most important step of the research process. It is like the identification of a destination before undertaking a journey. As in the absence of a destination, it is impossible to identify the shortest route, so also in the absence of a clear research problem, a clear and economical plan is impossible. A research problem is like the foundation of a building.

The type and design of the building is dependent upon the foundation. If the foundation is well designed and strong you can expect the building to be also strong and well designed. In the case of research, the research problem serves as the foundation of a research study. If it is well formulated, you can expect a good study to follow.

## Variables Used in Psychology Research

## Meaning of Variable

A variable, as the name implies, is something which varies. This is the simplest and the broadest way of defining a variable. Webster says that a variable is “a thing that is changeable” or “a quantity that may have a number of different values.” True, a variable is something that has at least two values, however, it is also important that the values of the variable be observable.

Thus, if what is being studied is a variable, it has more than one value and each value can be observed. For example, the outcome of throwing a die is a variable. That variable has six possible values (each side of the die has from one to six dots on it), each of which can be observed. In psychology, the variables of interest are often behaviours or the causes of behaviours. Many psychologists have adopted a theoretical viewpoint or model called the S-O-R model to explain all behaviour.

A variable is something that can be changed or varied, such as a characteristic or value. Variables are generally used in psychology experiments to determine if changes to one thing result in changes to another.

Variables play a critical role in the psychological research process. By systematically varying some variables and measuring the effects on other variables, researchers can determine if changes to one thing result in changes in something else.

The Dependent and Independent Variables

In a psychology experiment:[1]

- The **independent variable** is the variable that is controlled and manipulated by the experimenter. For example, in an experiment on the impact of sleep deprivation on test performance, sleep deprivation would be the independent variable.
- The **dependent variable** is the variable that is measured by the experimenter. In our previous example, the scores on the test performance measure would be the dependent variable.

**Extraneous and Confounding Variables**

It is important to note that the independent and dependent variables are not the only variables present in many experiments. In some cases, extraneous variables may also play a role. This type of variable is one that may have an impact on the relationship between the independent and dependent variables.

For example, in our previous description of an experiment on the effects of sleep deprivation on test performance, other factors such as age, gender, and academic background may have an impact on the results. In such cases, the experimenter will note the values of these extraneous variables so this impact on the results can be controlled for.

**There are two basic types of extraneous variables:**

1. **Participant Variables:** These extraneous variables are related to individual characteristics of each participant that may impact how he or she responds. These factors can include background differences, mood, anxiety, intelligence, awareness and other characteristics that are unique to each person.

2. **Situational Variables:** These extraneous variables are related to things in the environment that may impact how each participant responds. For example, if a participant is taking a test in a chilly room, the temperature would be considered an extraneous variable. Some participants may not be affected by the cold, but others might be distracted or annoyed by the temperature of the room.

**Other extraneous variables include the following:**

- **Demand characteristics:** Clues in the environment that suggest how a participant should behave
- **Experimenter effects:** When a researcher unintentionally suggests clues for how a participant should behave

In many cases, extraneous variables are controlled for by the experimenter. In the case of participant variables, the experiment might select participants that are the same in background and temperament to ensure that these factors do not interfere with the results.

Confounding Variables

If a variable cannot be controlled for, it becomes what is known as a **confounding variable**. This type of variable can have an impact on the dependent variable, which can make it difficult to determine if the results are due to the influence of the independent variable, the confounding variable or an interaction of the two.

## Operationally Defining a Variable Psychology

Before conducting a psychology experiment, it is essential to create firm operational definitions for both the independent variable and

dependent variable. An operational definition describes how the variables are measured and defined in the study.[1]

For example, in our imaginary experiment on the effects of sleep deprivation on test performance, we would need to create very specific operational definitions for our two variables. If our hypothesis is "Students who are sleep deprived will score significantly lower on a test," then we would have a few different concepts to define. First, what do we mean by students? In our example, let's define students as participants enrolled in an introductory university-level psychology course.

Next, we need to operationally define the sleep deprivation variable. In our example, let's say that sleep deprivation refers to those participants who have had less than five hours of sleep the night before the test. Finally, we need to create an operational definition for the test variable. For this example, the test variable will be defined as a student's score on a chapter exam in the introductory psychology course.

Students often report problems with identifying the independent and dependent variables in an experiment. While the task can become more difficult as the complexity of an experiment increases, there are a few questions you can ask when trying to identify a variable.

What is the experimenter manipulating? The things that change, either naturally or through direct manipulation from the experimenter, are generally the independent variables. What is being measured? The dependent variable is the one that the experimenter is measuring.

Every good psychology study contains an operational definition for the variables in the research. An operational definition allows the researchers to describe in a specific way what they mean when they use a certain term. Generally, operational definitions are concrete and measurable. Defining variables in this way allows other people to see if the research has validity. Validity here refers to if the researchers are actually measuring what they intended to measure.

Example One:

A researcher wants to measure if age is related to addiction. Perhaps their hypothesis is: the incidence of addiction will increase with age. Here we have two variables, age and addiction. In order to make the research as clear as possible, the researcher must define how they will measure these variables. Essentially, how do we measure someone's age and how to we measure addiction?

**Variable One:** Age might seem straightforward. You might be wondering why we need to define age if we all know what age is. However, one researcher might decide to measure age in months in order to get someone's precise age, while another researcher might just choose to measure age in years. In order to understand the results of the study, we will need to know how this researcher operationalized age. For the sake of this example lets say that age is defined as how old someone is in years.

**Variable Two:** The variable of addiction is slightly more complicated than age. In order to operationalize it the researcher has to decide exactly how they want to measure addiction. They might narrow down their definition and say that addiction is defined as going through withdrawal when the person stops using a substance. Or the researchers might decide that the definition of addiction is: if someone currently meets the DSM-5 diagnostic criteria for any

substance use disorder. For the sake of this example, let's say that the researcher chose the latter.

**Final Definition:** In this research study age is defined as participant's age measured in years and the incidence of addiction is defined as whether or not the participant currently meets the DSM-5 diagnostic criteria for any substance use disorder.

Need Operational Definitions

There are a number of reasons why researchers need to have operational definitions including:

- Validity
- Replicability
- Generalizability
- Dissemination

The first reason was mentioned earlier in the post when reading research others should be able to assess the validity of the research. That is, did the researchers measure what they intended to measure? If we don't know how researchers measured something it is very hard to know if the study had validity.

The next reason it is important to have an operational definition is for the sake of replicability Research should be designed so that if someone else wanted to replicate it they could. By replicating research and getting the same findings we validate the findings. It is impossible to recreate a study if we are unsure about how they defined or measured the variables.

Another reason we need operational definitions is so that we can understand how generalizable the findings are. In research, we

want to know that the findings are true not just for a small sample of people. We hope to get findings that generalize to the whole population. If we do not have operational definitions it is hard to generalize the findings because we don't know who they generalize to.

Finally, operational definitions are important for the dissemination of information. When a study is done it is generally published in a peer-reviewed journal and might be read by other psychologists, students, or journalists. Researchers want people to read their research and apply their findings. If the person reading the article doesn't know what they are talking about because a variable is not clear it will be hard to them to actually apply this new knowledge.

## Hypothesis of Psychology

In conducting research, the second important consideration after the formulation of a research problem is the construction of hypothesis. As you know any scientific inquiry starts with the statement of a solvable problem, when the problem has been stated, a tentative solution in the form of testable proposition is offered by the researcher.

The testable proposition and potential answer are termed a hypothesis Therefore a hypothesis is nothing but a suggested, testable and proposed answer to a problem. By stating a specific hypothesis, the researcher narrows the focus of the data collection effort and is able to design a data collection procedure which is aimed at testing the plausibility of the hypothesis as a possible statement of the relationship between the terms of the research problem.

Definition of Hypothesis Several experts have defined hypothesis more or less in the same way. According to Kerlinger (1973), a hypothesis is a conjectural statement of the relation between two or more variables. According to Mcquigan (1970) hypothesis is a testable statement having the potential relationship between two or more variables. In other words, the hypothesis in one way is advanced as a potential solution to problem.

On the basis of these definitions two criteria for good hypothesis and hypothesis statement can be suggested: i) Hypotheses are statements about the relation between variables. ii) Hypotheses carry clear implication for testing the stated relations. These criteria mean that hypothesis contains two or more variables which are measurable or potentially measurable and hypothesis exhibits either a general or specific relationship between the variables.

**Characteristics of a Hypothesis**

There are a number of considerations one should keep in mind when constructing a hypothesis, as they are important for valid verification. Hypothesis should be simple, specific and conceptually clear.

There is no place of ambiguity in the construction of a hypothesis it should be ‘unidimensional i.e. it should test only one relationship at a time. For example; the average scores in maths subjects of the male students in the class is higher than the female students. Suicides rates very inversely with the social cohesion (Black & Champion 1976).

A Hypothes thus should be capable of verification: methods and techniques must be available for data collection. A hypothesis should be operationlisable. This means that it can be expressed in

terms that can be measured. If it cannot be measured and tested and, hence, no conclusions can be drawn.

A Hypothesis should be related to the existing body of knowledge.

A hypothesis has equal chances of confirmation and rejection.

A hypothesis should be parsimonious. (economical)

A hypothesis should be method oriented. In the construction of hypotheses the student must observe the above mentioned rules.

Forming acceptable hypotheses is not difficult if the problem giving rise to the hypotheses has been carefully stated and defined. The form of a hypothesis can be a declarative statement containing a suggested answers to the problem, and which obeys the formal conditions of hypothesis. Following are two examples of problems and their respective hypothesis. Problem

1: Does practice with the preferred hand improve the proficiency of the nonpreferred hand in the mirror drawing experiment ? Hypothesis: Practice with the preferred hand significantly improves the proficiency of the nonpreferred hand in the mirror drawing experiment. Problem

2: Are male rats more active than the same strain of female rats during a 6- day period spent in an activity cage ? Hypothesis: Male rats are not significantly more active than the same strain of female rats during a 6-day period spent in an activity cage.

Functions of Hypothesis A hypothesis serves the following functions:

i) The formulation of a hypothesis provides a study with focus.

ii) It tells you what specific aspects of a research problem to investigate

iii) It tells what data to collect and what not to collect

iv) The construction of a hypothesis enhances objectivity in a study. The process of testing a hypothesis goes through 3 phases as given below (Kumar, 2002 : Research methodology))

Phase

I: Formulate your hunch or assumption Phase

II: Collect the required data Phase

III: Analyse data to draw conclusion about the hunch – true or false. A hypothesis may enable you to add to the formulation of theory. It enables you to specifically conclude what is true or what is false.

Let's consider a hypothesis that many teachers might subscribe to: that students work better on Monday morning than they do on a Friday afternoon (IV=Day, DV=Standard of work).

Now, if we decide to study this by giving the same group of students a lesson on a Monday morning and on a Friday afternoon and then measuring their immediate recall on the material covered in each session we would end up with the following:

- The **alternative hypothesis** states that students will recall significantly more information on a Monday morning than on a Friday afternoon.
- The **null hypothesis** states that there will be no significant difference in the amount recalled on a Monday morning compared to a Friday afternoon. Any difference will be due to chance or confounding factors.

## Sampling of Psychology

- Sampling is the process of selecting a representative group from the population under study.
- The target population is the total group of individuals from which the sample might be drawn.
- A sample is the group of people who take part in the investigation. The people who take part are referred to as “participants”.
- Generalisability refers to the extent to which we can apply the findings of our research to the target population we are interested in.

## The Purpose of Sampling

In psychological research we are interested in learning about large groups of people who all have something in common. We call the group that we are interested in studying our 'target population'.

In some types of research the target population might be as broad as all humans, but in other types of research the target population might be a smaller group such as teenagers, pre-school children or people who misuse drugs.

It is more or less impossible to study every single person in a target population so psychologists select a sample or sub-group of the population that is likely to be representative of the target population we are interested in.

This is important because we want to generalize from the sample to target population. The more representative the sample, the more

confident the researcher can be that the results can be generalized to the target population.

One of the problems that can occur when selecting a sample from a target population is sampling bias. Sampling bias refers to situations where the sample does not reflect the characteristics of the target population.

Many psychology studies have a biased sample because they have used an opportunity sample that comprises university students as their participants (e.g. Asch).

OK, so you've thought up this brilliant psychological study and designed it perfectly. But who are you going to try it out on and how will you select your participants?

There are various sampling methods. The one chosen will depend on a number of factors (such as time, money etc.).

Random Sampling

Random sampling is a type of probability sampling where everyone in the entire target population has an **equal chance** of being selected.

This is similar to the national lottery. If the "population" is everyone who has bought a lottery ticket, then each person has an equal chance of winning the lottery (assuming they all have one ticket each).

Random samples require a way of naming or numbering the target population and then using some type of raffle method to choose those to make up the sample. Random samples are the best method of selecting your sample from the population of interest.

The **advantages** are that your sample should represent the target population and eliminate sampling bias, but the **disadvantage** is that it is very difficult to achieve (i.e. time, effort and money).

**Opportunity Sampling**

Uses people from target population available at the time and willing to take part. It is based on **convenience**.

An opportunity sample is obtained by asking members of the population of interest if they would take part in your research. An example would be selecting a sample of students from those coming out of the library.

## Ethics in conducting and reporting research of Psychology

Ethics refers to the correct rules of conduct necessary when carrying out research. We have a moral responsibility to protect research participants from harm.

However important the issue under investigation psychologists need to remember that they have a duty to respect the rights and dignity of research participants. This means that they must abide by certain moral principles and rules of conduct.

In Britain, ethical guidelines for research are published by the British Psychological Society and in America by the American Psychological Association. The purpose of these codes of conduct is to protect research participants, the reputation of psychology, and psychologists themselves.

### Ethical Issues in Psychology

1. Informed Consent

2. Debrief
3. Protection of Participants
4. Deception
5. Confidentiality
6. Withdrawal

Moral issues rarely yield a simple, unambiguous, right or wrong answer. It is therefore often a matter of judgment whether the research is justified or not. For example, it might be that a study causes psychological or physical discomfort to participants, maybe they suffer pain or perhaps even come to serious harm.

On the other hand, the investigation could lead to discoveries that benefit the participants themselves or even have the potential to increase the sum of human happiness. Rosenthal and Rosnow (1984) also talk about the potential costs of failing to carry out certain research. Who is to weigh up these costs and benefits? Who is to judge whether the ends justify the means?

Finally, if you are ever in doubt as to whether research is ethical or not it is worthwhile remembering that if there is a conflict of interest between the participants and the researcher it is the interests of the subjects that should take priority.

Studies must now undergo an extensive review by an institutional review board (US) or ethics committee (UK) before they are implemented. All UK research requires ethical approval by one or more of the following:

(a) Department Ethics Committee (DEC): for most routine research.

(b) Institutional Ethics Committee (IEC): for non routine research.

(c) External Ethics Committee (EEC): for research that is externally regulated (e.g. NHS research).

Committees review proposals assess if the potential benefits of the research are justifiable in the light of the possible risk of physical or psychological harm. These committees may request researchers make changes to the study's design or procedure, or in extreme cases deny approval of the study altogether.

The British Psychological Society (BPS) and American Psychological Association (APA) have both issued a code of ethics in psychology that provides guidelines for the conduct of research. Some of the more important ethical issues are as follows:

**Informed Consent**

Whenever possible investigators should obtain the consent of participants. In practice, this means it is not sufficient to simply get potential participants to say “Yes”. They also need to know what it is that they are agreeing to. In other words, the psychologist should, so far as is practicable explain what is involved in advance and obtain the informed consent of participants.

Before the study begins the researcher must outline to the participants what the research is about, and then ask their consent (i.e. permission) to take part. An adult (18ys +) capable of giving permission to participate in a study can provide consent. Parents/legal guardians of minors can also provide consent to allow their children to participate in a study.

However, it is not always possible to gain informed consent. Where it is impossible for the researcher to ask the actual participants, a similar group of people can be asked how they would feel about

taking part. If they think it would be OK then it can be assumed that the real participants will also find it acceptable.

In order that consent be 'informed', consent forms may need to be accompanied by an information sheet for participants setting out information about the proposed study (in lay terms) along with details about the investigators and how they can be contacted.

**Participants must be given information relating to**:

- A statement that participation is voluntary and that refusal to participate will not result in any consequences or any loss of benefits that the person is otherwise entitled to receive.
- Purpose of the research.
- All foreseeable risks and discomforts to the participant (if there are any). These include not only physical injury but also possible psychological.
- Procedures involved in the research.
- Benefits of the research to society and possibly to the individual human subject.
- Length of time the subject is expected to participate.
- Person to contact for answers to questions or in the event of injury or emergency.
- Subjects' right to confidentiality and the right to withdraw from the study at any time without any consequences.

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**Debrief**

After the research is over the participant should be able to discuss the procedure and the findings with the psychologist. They must be given a general idea of what the researcher was investigating and why, and their part in the research should be explained.

Participants must be told if they have been deceived and given reasons why. They must be asked if they have any questions and those questions should be answered honestly and as fully as possible.

Debriefing should take place as soon as possible and be as full as possible; experimenters should take reasonable steps to ensure that participants understand debriefing.

"The purpose of debriefing is to remove any misconceptions and anxieties that the participants have about the research and to leave them with a sense of dignity, knowledge, and a perception of time not wasted" (Harris, 1998).

The aim of the debriefing is not just to provide information, but to help the participant leave the experimental situation in a similar frame of mind as when he/she entered it (Aronson, 1988).

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## Protection of Participants

Researchers must ensure that those taking part in research will not be caused distress. They must be protected from physical and mental harm. This means you must not embarrass, frighten, offend or harm participants.

Normally, the risk of harm must be no greater than in ordinary life, i.e. participants should not be exposed to risks greater than or additional to those encountered in their normal lifestyles.

The researcher must also ensure that if vulnerable groups are to be used (elderly, disabled, children, etc.), they must receive special care. For example, if studying children, make sure their participation is brief as they get tired easily and have a limited attention span.

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# What is Paradigms of research: Quantitative, Qualitative, Mixed methods approach Methods of research: Observation, Survey [Interview, Questionnaires], Experimental, Quasi-experimental, Field studies, Cross-Cultural Studies, Phenomenology, Grounded theory, Focus groups, Narratives, Case studies, Ethnography?

**Paradigms of research: Quantitative, Qualitative, Mixed methods approach Methods of research: Observation, Survey [Interview, Questionnaires], Experimental, Quasi-experimental, Field studies, Cross-Cultural Studies, Phenomenology, Grounded theory, Focus groups, Narratives, Case studies, Ethnography**

**The Paradigms of research: Quantitative, Qualitative, Mixed methods approach**

**Methods of research:**

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The aim of this paper is to discuss the philosophical tenets of the major research frameworks which postgraduate students in educational research work with but which they are often confused about. Such a clarification is important inasmuch as it determines not only the research methodology which will be followed but also the choice of the appropriate research methods and the procedure used for the analysis of the collected data. The various research schemes and their corresponding philosophical background will be discussed and concrete examples will be provided to help research students better understand the issues at stake.

These definitions of educational research point at some important issues: First and foremost, the research procedure must answer the canons of 'science' then, the information provided must be reliable, and finally, what is being investigated should be of interest to educators who may carry out their research within or outside the educational institution. Also implicit in these definitions is the fact that educational research must use the same methods as those used in natural sciences in order to come up with answers aimed at improving teaching and learning as well as identifying the conditions for testing and verifying this knowledge and the conditions under which it should occur.

It is thus of paramount importance for research students to grasp the fundamentals of these issues since they determine the choices they have to make at all stages of their research which invariably include the following: the choice of a research framework, the selection of the appropriate research tools for the collection of the data, the procedure(s) to be followed for their analysis, and ultimately, the nature of the conclusions they will have to draw. They must be aware that all existing research frameworks reflect shifts in

scientific thought which can be traced back to the debate among leading Greek philosophers as to how new knowledge is acquired.

These philosophers challenged earlier explanations based on theological tenets and argued that a better and more systematic understanding of the world could be obtained either through our senses as the empiricist school claimed , or through logical reasoning as the rationalist school believed. Subsequent shifts in scientific thought, as we shall see, will lead to new perceptions as to how knowledge can be derived from, leading thus to new research paradigms.

justify the choice of a particular framework or paradigm. The latter is defined by Chalmers (1982:11) as being "made up of the general theoretical assumptions and laws, and techniques for their application that the members of a particular scientific community adopt", and by Willis (2007:8) as "a comprehensive belief system, world view, or framework that guides research and practice in a field" Such understanding will hopefully help them make the appropriate choices about :

(1) Their research question(s) or hypothesis

(2) the type of the research instruments to be used,

(3) the steps involved in the collection of the data, and ultimately

(4) the procedure used for the analysis and discussion of the collected data We shall briefly explain how these shifts in scientific thought have occurred and how they have led to the major shifts in research paradigms and then, we shall show how these shifts had an impact on research methods and methodologies.

It will be reminded that the term 'method' is used to refer to the research instruments used to collect and analyse data, e.g. a questionnaire, interview, checklist, data analysis software etc.

**Research Philosophy: Historical**

Background The type of research methodology the researcher chooses is determined by the research philosophy which the researcher adheres to and this choice will determine the research objective(s) and the research instruments developed and used as well as the quest for the solution to the problem he is investigating. So far, Empiricism and Rationalism have been the most prevailing research philosophies.

These can be traced back to the debate we mentioned earlier between the Empiricists who were inductivists and the Rationalists who were deductivists. These two opposing views will follow different ways in explaining how knowledge is acquired: either through inductive reasoning as the Empiricists believed or by reasoning as the Rationalists maintained. Therefore, the Inductive/Deductive distinction can be considered as the first major paradigm in science.

The Inductive reasoning (or bottom-up process) starts from specific observations and moves towards a general conclusion or theory. For example, I observe that all the elephants I have seen (repeated observations) have a trunk, therefore I conclude that ALL existing elephants, even those I have not seen, HAVE a trunk (conclusion, or generalisation). Whereas deductive reasoning (also known as top-down process) proceeds differently. The starting point is a general statement (called the first premise, or theory) followed by a more specific statement inferred from this (the second premise, or the observed phenomenon) and, through logical reasoning, reaches

a specific conclusion. As an illustration, I know that all planets orbit around the sun (first premise), a new planet is discovered (second premise), therefore I can conclude that this planet also orbits the sun.

This debate was revisited after the Renaissance and witnessed a heated dispute between the Rationalists represented by the French philosopher René Descartes (1596–1650) who argued that Reason was the only mode through which one could arrive at truth and assumed thus, that knowledge could only be acquired if the appropriate reasoning procedure was used, and the Empiricists represented by the British philosophers John Locke (1632–1704) and David Hume (1711–1776) who argued that experience was the basis for acquiring all new knowledge.

It was Locke who put forward the well known formula that each person is born as a blank slate upon which the environment writes. For these philosophers our knowledge derives from our senses (sight, hearing, touch, smell, and taste) which then imprint ideas in our brain which are further worked upon through cognitive processes. However, it must be stressed that both trends were primarily concerned with natural sciences since at that time social sciences had no place as they were considered as being subjective and thus, not treated as real sciences.

## Research Paradigms and Types of Studies

We shall now turn to discussing the implications that each paradigm has for the design of the various types of research studies in educational research. This is summarised in Figure 2 below, while Figure 3 lists the criteria to be used for identifying the various types of research, and Figure 4 lists all the research instruments which can be used in all three paradigms and for ensuring triangulation.

## Quantitative research studies

There are two types of quantitative studies: either experimental or non experimental 3.1.1 Experimental studies Experimental studies can be either a true experiment, a quasi experiment or a single case study.

The latter is very rarely used in educational research because it is concerned with only one subject. However, one must keep in mind that the single-subject study may be seen as a true experiment because it as a long and respected tradition in empirical research particularly in psychology.

According to Kazdin (2003:273), single-subject studies "can demonstrate causal relationships and can rule out or make implausible threats to validity with the same elegance of group research". The single subject design has objectives similar to other experimental designs, in that

(1) it looks at the changes in the dependent variable following the manipulation of the independent variable and

(2) it tries to identify the causes of the differences brought about by the variations in the conditions of the study. As far as the other two types are concerned, what differentiates a true experiment from a quasi experiment study is the fact that in the former, the researcher can manipulate the variables under stringent and controlled conditions to study the effect or the impact of one variable (the independent, also called predictor one) on the other variable (the dependent, or outcome variable) to make statements of causality.

This type of research has weaker validity and poor reliability because the researcher cannot establish cause-and-effect

relationships and cannot manipulate the predictor variables. Here are some examples for each type of research:

(i) True experimental :

a) The effect of small classes on instruction

b) The use of intensive mentoring to help beginning teachers develop balanced instruction

(ii) Quasi Experiment

a) Are lectures given in the morning memorized better than when given in the afternoon?

b) Do teachers' teaching styles play a role in students' motivation for learning?

Non experimental studies These are research studies in which there is no manipulation of the independent variable by the experimenter either for ethical reasons (for example the impact of smoking on health) or because of their abstract nature (for example age, gender , ethnicity opinions etc.). Non experimental research covers a wide variety of studies, such as

(i) descriptive,

(ii) causal-comparative,

(iii) correlational,

(iv) ex post facto research, and

(v) surveys

(i) Descriptive research, as the name suggests, helps the researcher to collect data about conditions, situations, and events that occur in the present. For example:

a) Attitudes of parents toward introducing school outings on Sundays.

b) How do university teachers spend their time?

c) How do parents feel about a four day school schedule?

(ii) Causal-comparative research aims investigates the relation between the variables under study in order to identify possible causal relationships between them. For example :

a) Effect of birth order on academic achievement

b) The effect of having a working mother on school achievements

c) The effect of age on achievements in learning a foreign language

(iii) Correlational research is concerned with establishing possible but not necessarily present relationships between variables. Examples of correlational studies:

a) Do male students perform better than female in scientific subjects?

b) The relationship between parents' socio-economic status and their children's school achievements

c) The relationship between stress and achievement

(iv) Ex post facto research: Ex-post facto literally means "from what is done afterwards". It focuses first on the effect, then tries to determine possible causes and questions will remain about the effect following the cause, or vice versa. In this type of research, the researcher cannot control the variables; his role is limited to reporting the outcome of an action or what is happening.

**Qualitative research studies**

a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem.

The process of research involves emerging questions and procedures. Data typically collected in the participant's setting. data analysis inductively building from particulars to general themes. and the researcher making interpretations of the meaning of the data.

This type of research relies primarily on collecting qualitative data (i.e., non-numerical or categorical data such as words and pictures etc.), and can be either interactive or non interactive (i.e. whether the researcher is personally.

**Interactive**

In educational research there is very little room for a personal involvement or immersion of the researcher with the participants of the study, as his role is mostly that of an observer. However, there may be instances where such research can be carried out. The first of these is phenomenology which is the descriptive study of how individuals experience a phenomenon. In this type of research the researcher aims at understanding how individuals' lives are organised and structured. For example:

a) What are students' attitudes towards an uncaring teacher?

b) What are teachers' attitudes and beliefs towards teaching?

The second major approach to qualitative research is ethnography (i.e., the discovery and description of the culture of a group of people). Because it is deeply rooted in anthropology the concept of culture is of central importance in this type of research. In the case

of educational research one can study the culture in a classroom. Examples of these would be :

a) How do learners react to cultural differences in foreign language classes?

b) How do teachers deal with cultural conflicts in their classes?

**Non Interactive**

Non interactive qualitative studies are mainly concerned with historical analysis or content analysis. In historical analysis the researcher aims at establishing descriptions, and coming up, whenever possible, with explanations, of what has occurred. For example, a study can document

(i) the changes in the assessment procedures in EFL classes over the past ten years, or

(ii) the developments in the testing procedures of English in the Baccalaureate over the past twenty years. In content analysis the researcher analyzes written documents or other communication media (e.g., photographs, movies, advertisements) in a given topic in order to identify

the information and symbols they contain . The researcher identifies a body of material to analyze (e.g., school textbooks, television programs, newspaper articles etc ) and then posits a system for recording specific aspects of its content. Content analysis is a nonreactive method because the researcher didn't know about the content beforehand.

For example a researcher might be interested in investigating how school violence is reported in the media or how women are represented in school textbooks.

## Mixed Methods research

This research paradigm is used extensively in educational research for its many merits. Thus, in mixed methods researchers use both types of data because these combined provide the best understanding of a research problem. It has been defined variously by many researchers.

For Janice Morse it is a plan for a scientifically rigorous research process comprised of a qualitative or quantitative core component that directs the theoretical drive, with qualitative or quantitative supplementary components. These components of the research fit together to enhance description, understanding and can either be conducted simultaneously or sequentially

## Conclusion

Research is the acquisition of knowledge in a systematic and organised way. However, the routes leading to the discovery of this new knowledge varies according to the philosophical tenets to which the researcher adheres. This is why the research paradigms which determine the existing research methodologies cannot be fully grasped without a thorough understanding of the epistemological issues which underpin each of them . The inductive-deductive debate which will grow into the quantitative-qualitative methodologies is the direct result of evolving beliefs as to what constitutes the most efficient and most reliable way of carrying the research.

It is true however, that the nature of the data, either natural or social and psychological will direct the researcher to a great extent towards one or another methodology. The frontier between the two is becoming blurred and justifies the resort to a methodology which

uses the strengths of the of the two major paradigms, i.e. a mixed method approach. As far as educational research is concerned the choice of one or another methodology depends very much on the nature of the variables being investigated and the more the researcher is aware of the philosophical tenets of the methodology he intends to use the easier the choice of the appropriate research process will be.

**Qualitative Inquiry in the History of Psychology**

The great irony of qualitative inquiry in psychology is that, despite and in part due to its ubiquity, little history has been written. As our knowledge moves further into the past, it becomes murkier even though qualitative research has been practiced long before and continually since the establishment of psychology as an independent science. Studying historical roots is especially difficult because qualitative inquiry is performed in all fields and predates the current organization of knowledge by means of the various sciences, humanities, arts and professions. Moreover, an interdisciplinary cross fertilization of qualitative methods continues to flourish wildly today.

The historian, in the face of qualitative inquiry in psychology, must be awe struck. Such awe can inspire creative scholarship about the history of qualitative inquiry, and there is no better time than the present, which is more hospitable than ever before to such efforts. One of the aims of this article is to begin to address the question of what qualitative research is--what it looks like in psychology, by recognizing past instances of such practices that have not previously been identified as such.

Understanding these modes of inquiry will be greatly enhanced if we develop our sensitivities and bring this work out of the shadows,

from the bottom up, with deliberately open naiveté. A second aim is to provide a rough sketch of a history of qualitative inquiry in psychology that differentiates phases from the founding of psychology to the present.

This sketch highlights landmark events as an invitation to appreciate such moments and identify others rather than to bring any closure to what is historically important. Finally, several examples of psychology conducted before the term “qualitative research” entered our vocabulary are presented in order to illustrate the potential of historical exploration of the hidden treasures of this field. Now that these practices have finally become a thematic object of scientific interest, such reconnaissance work will inform and benefit present and future generations of psychologists, better positioning them to understand and use all available means of inquiry.

It is misleading to speak of “the” history of qualitative inquiry in light of the diversity and complexity of the field, which is virtually coextensive with psychology itself. The genealogy of qualitative research is not well represented by a tree with roots denoting precursors, a single trunk depicting a great inventor/pioneer, and many large and smaller branches extending in directions signifying the progress of followers to their most recently budding contributions. Rather, qualitative methods in psychology are better represented as an expansive forest with many trees of various ages and distances from each other,

some growing symbiotically, some competing for sunlight and others ascending in isolation as they rise fromsubterranean root systems that intermingle in an invisible community from common and different kinds of nourishing soil.

Qualitative inquiry is ubiquitous because of its fundamental necessity and place in the enterprise of science. Scientific knowledge is inconceivable without some rational determination of what its subject matter is, and answers to the 'what' question require some manner of qualitative inquiry. Hypothesis testing and measurement, for instance, cannot proceed except on the basis of some conceptualization of what the hypothesis is about, what is to be observed and measured. The logic and practice of empirical science requires evidence, and the determination of its relevance and validity requires qualitative knowledge and judgment.

The equation of science with hypothesis testing has led to an emphasis on measurement issues and statistical reasoning, with little attention to inductive, interpretive, and other rational means of defining constructs, even though it is a crucial and indispensible part of all scientific research.

Qualitative inquiry and knowledge can range from being highly implicit and taken for granted, even free wheeling and unsystematic, to being rigorously established and accounted for with specially designed and critically evaluated research procedures. Qualitative reasoning and practices have not long been a part of our discipline's formal methodology, and even today there is limited if any presentation of them in the education and training of research psychologists. The present examination focuses primarily on the self-conscious and deliberate scientific practice of qualitative research.

## Qualitative Research Practice Without Methodology

Qualitative inquiry can certainly be traced back to ancient times, for instance in the work of Aristotle. The qualitative tradition of naturalism was developed and applied in psychology by Darwin

(1871 & 1872), in his classic comparative investigations of emotions and moral sense. The tradition of case history, as a means of establishing general knowledge, had long been employed in medicine when Freud used it in his research on psychopathology (Freud & Breuer, 1895). Although the official founding of psychology in 1879 is marked by the first psychological laboratory, Wundt's experimental work was only a part of the psychology he conceived and practiced. Recent historians (Danziger, 1983, 2003) inform us that Wundt viewed his 10 volume Völkerpsychologie (1900-1920, & 1916) translated as "social psychology," "folk psychology," or "cultural psychology"),

involving qualitative research on language, expressive movement, imagination, art, mythology, religion, and morality, as equally important to laboratory research in the science of psychology. Psychologists of no less stature than Sigmund and Anna Freud, Carl Jung, William James, E.B. Tichener, Max Wertheimer and the Gestalt school, Kurt Lewin, John Watson, Wilhelm Stern, Jean Piaget, Lev Vygotsky, Frederick Bartlett, John Dollard, Abraham Maslow, Lawrence Kohlberg, Carol Gilligan, Leon Festinger, Stanley Schacter, Philip Zimbardo, and David Rosenhan have also contributed ground breaking, well known research in psychology without their qualitative methods receiving much attention even to this date.

It is significant that the two psychologists who were awarded Nobel Prizes (in Economics)--Herbert Simon and Daniel Kahneman, both won their distinction by carrying out inquiries on thinking and problem solving by developing mathematical models based on verbal description and a qualitative analysis of everyday problem solving (Ericcson & Simon, 1993 & Kahneman, 2003). There can be

little question that qualitative inquiry has played a very important part in the history of psychology.

The Call for Qualitative Methodology In 1940, the Social Science Research Council, charged with improving the quality of research in the social sciences, enlisted the Committee on Appraisal of Research, chaired by Edmund Day, to appraise research on psychological and social life focusing on “the subjective factor” by using “human documents” as source materials.

The Committee asked Gordon Allport to investigate the use in psychology of “any self revealing record that intentionally or unintentionally yields information about the structure, dynamics, or functioning of the author’s mental life” (Allport, 1942, p. xii). Allport’s survey and evaluation, published in a 1942 monograph, addressed such questions as the nature of this first person materials (e.g., autobiographies, questionnaires, verbatim recordings such as interviews, diaries/journals, letters, and expressive/artistic productions);

the history of the employment of such documents; attempts to establish the reliability and validity of procedures; howinvestigators accounted for their methods; the kind(s) of analyses used; the employment of induction, illustration and hypotheses; how inferences were generalized; and the biases or frames of reference of investigators. Allport estimated that although two or three hundred psychological authors had employed personal documents, no more than a dozen had given thought to the method they had employed, and there were very few critical studies of these methods.

**The Development of Qualitative Methodologies**

Qualitative research continued in psychology unabated, but Allport's monograph did not result in a widespread recognition of the value of these methods for more than a generation. In the next decade and through the 1960s, qualitative research was practiced and even developed, but the vast majority of researchers who continued to use these methods did so without accounting systematically for their procedures or asserting their scientific value. As mentioned above, one noteworthy example of such innovative studies is Kohlberg's 1954 dissertation. The details of his method were not reported in his subsequent publications and became available only when the actual dissertation was published in 1994, when qualitative research was becoming a common concern of psychologists. Only recently has this work begun to receive methodological attention (Wertz et al, 2011).

Other good examples of the continuing innovation and development of qualitative inquiry are Maslow's studies of the self-actualized personality (1954, 1968), which Maslow initially hesitated to publish because he himself viewed his method as of purely personal interest and insufficiently scientific. After Maslow submitted the self-actualization study for publication because he viewed the findings as important, the manuscript was rejected for publication by leading psychological journals.

A persistent Maslow delivered his very methodologically interesting study of self actualization as his presidential address to APA in 1958 and bitterly refused any further submission his work for publication in psychology's top tier journals. He viewed his methods as being of sufficient scientific value to continue and extend them in his fruitful investigation of peak experiences (1959), for which he gathered participants' descriptions of their best experiences, and

disseminated his very influential research on self actualization and peak experiences in his books.

## Methods of research: Observation, Survey [Interview, Questionnaires]

Primary Research: Definitions and Overview How research is defined varies widely from field to field, and as you progress through your college career, your coursework will teach you much more about what it means to be a researcher within your field.* For example, engineers, who focus on applying scientific knowledge to develop designs, processes, and objects, conduct research using simulations, mathematical models, and a variety of tests to see how well their designs work. Sociologists conduct research using surveys, interviews, observations, and statistical analysis to better understand people, societies, and cultures.

Graphic designers conduct research through locating images for reference for their artwork and engaging in background research on clients and companies to best serve their needs. Historians conduct research by examining archival materials— newspapers, journals, letters, and other surviving texts—and through conducting oral history interviews.

Rather, individuals conducting research are producing the articles and reports found in a library database or in a book. Primary research, the focus of this essay, is research that is collected firsthand rather than found in a book, database, or journal. Primary research is often based on principles of the scientific method, a theory of investigation first developed by John Stuart Mill in the nineteenth century in his book Philosophy of the Scientific Method.

Although the application of the scientific method varies from field to field, the general principles of the scientific method allow researchers to learn more about the world and observable phenomena. Using the scientific method, researchers develop research questions or hypotheses and collect data on events, objects, or people that is measurable, observable, and replicable. The ultimate goal in conducting primary research is to learn about something new that can be confirmed by others and to eliminate our own biases in the process.

**Essay Overview and Student**

Examples The essay begins by providing an overview of ethical considerations when conducting primary research, and then covers the stages that you will go through in your primary research: planning, collecting, analyzing, and writing. After the four stages comes an introduction to three common ways of conducting primary research in first year writing classes:

• Observations. Observing and measuring the world around you, including observations of people and other measurable events.

• Interviews. Asking participants questions in a one-on-one or small group setting.

• Surveys. Asking participants about their opinions and behaviors through a short questionnaire.

In addition, we will be examining two student projects that used substantial portions of primary research: Derek Laan, a nutrition major at Purdue University, wanted to learn more about student eating habits on campus. His primary research included observations of the campus food courts, student behavior while in the food courts, and a survey of students' daily food intake. His

secondary research included looking at national studenteating trends on college campuses, information from the United States Food and Drug Administration, and books on healthy eating. Jared Schwab, an agricultural and biological engineering major at Purdue, was interested in learning more about how writing and communication took place in his field. His primary research included interviewing a professional engineer and a student who was a senior majoring in engineering. His secondary research included examining journals, books, professional organizations, and writing guides within the field of engineering.

**Ethics of Primary Research**

Both projects listed above included primary research on human participants; therefore, Derek and Jared both had to consider research ethics throughout their primary research process. As Earl Babbie writes in The Practice of Social Research, throughout the early and middle parts of the twentieth century researchers took advantage of participants and treated them unethically.

During World War II, Nazi doctors performed heinous experiments on prisoners without their consent, while in the U.S., a number of medical and psychological experiments on caused patients undue mental and physical trauma and, in some cases, death. Because of these and other similar events, many nations have established ethical laws and guidelines for researchers who work with human participants.

In the United States, the guidelines for the ethical treatment of human research participants are described in The Belmont Report, released in 1979. Today, universities have Institutional Review Boards (or IRBs) that oversee research. Students conducting research as part of a class may not need permission from the

university's IRB, although they still need to ensure that they follow ethical guidelines in research. The following provides a brief overview of ethical considerations:

**Voluntary participation**

The Belmont Report suggests that, in most cases, you need to get permission from people before you involve them in any primary research you are conducting. If you are doing a survey or interview, your participants must first agree to fill out your survey or to be interviewed. Consent for observations can be more complicated, and is discussed later in the essay.

**Confidentiality and anonymity**

Your participants may reveal embarrassing or potentially damaging information such as racist comments or unconventional behavior. In these cases, you should keep your participants' identities anonymous when writing your results. An easy way to do this is to create a "pseudonym" (or false name) for them so that their identity is protected.

**Researcher bias**

There is little point in collecting data and learning about something if you already think you know the answer! Bias might be present in the way you ask questions, the way you take notes, or the conclusions you draw from the data you collect.

**Planning Your Primary Research Project**

The primary research process is quite similar to the writing process, and you can draw upon your knowledge of the writing process to understand the steps involved in a primary research project. Just like in the writing process, a successful primary research project

begins with careful planning and background research. This section first describes how to create a research timeline to help plan your research. It then walks you through the planning stages by examining when primary research is useful or appropriate for your first year composition course, narrowing down a topic, and developing research questions.

**The Research Timeline**

When you begin to conduct any kind of primary research, creating a timeline will help keep you on task. Because students conducting primary research usually focus on the collection of data itself, they often overlook the equally important areas of planning (invention), analyzing data, and writing. To help manage your time, you should create a research timeline, such as the sample timeline presented here.

**When Primary Research Is Useful or Appropriate** In

**Evaluating Scientific Research:**

Separating Fact from Fiction, Fred Leavitt explains that primary research is useful for questions that can be answered through asking others and direct observation. For first year writing courses, primary research is particularly useful when you want to learn about a problem that does not have a wealth of published information.

This may be because the problem is a recent event or it is something not commonly studied. For example, if you are writing a paper on a new political issue, such as changes in tax laws or healthcare, you might not be able to find a wealth of peer-reviewed research because the issue is only several weeks old. You may find it necessary to collect some of your own data on the issue to supplement what you found at the library.

Primary research is also useful when youare studying a local problem or learning how a larger issue plays out at the local level. Although you might be able to find information on national statistics for healthy eating, whether or not those statistics are representative of your college campus is something that you can learn through primary research.

## Developing Research

Questions or Hypotheses As John Stuart Mill describes, primary research can use both inductive and deductive approaches, and the type approach is usually based on the field of inquiry.

Some fields use deductive reasoning, where researchers start with a hypothesis or general conclusion and then collect specific data to support or refute their hypothesis.

Other fields use inductive reasoning, where researchers start with a question and collect information that eventually leads to a conclusion. Once you have spent some time reviewing the secondary research on your topic, you are ready to write a primary research question or hypothesis. A research question or hypothesis should be something that is specific, narrow, and discoverable through primary research methods. Just like a thesis statement for a paper, if your research question or hypothesis is too broad, your research will be unfocused and your data will be difficult to analyze and write about. Here is a set of sample research questions:

## Observations

Observations have lead to some of the most important scientific discoveries in human history. Charles Darwin used observations of the animal and marine life at the Galapagos Islands to help him formulate his theory of evolution that he describes in On the Origin

of Species. Today, social scientists, natural scientists, engineers, computer scientists, educational researchers, and many others use observations as a primary research method. Observations can be conducted on nearly any subject matter, and the kinds of observations you will do depend on your research question. You might observe traffic or parking patterns on campus to get a sense of what improvements could be made. You might observe clouds, plants,

or other natural phenomena. If you choose to observe people, you will have several additional considerations including the manner in which you will observe them and gain their consent. If you are observing people, you can choose between two common ways to observe: participant observation and unobtrusive observation. Participant observation is a common method within ethnographic research in sociology and anthropology. In this kind of observation, a researcher may interact with participants and become part of their community.

Margaret Mead, a famous anthropologist, spent extended periods of time living in, and interacting with, communities that she studied. Conversely, in unobtrusive observation, you do not interact with participants but rather simply record their behavior. Although in most circumstances people must volunteer to be participants in research, in some cases it is acceptable to not let participants know you are observing them. In places that people perceive as public, such as a campus food court or a shopping mall, people do not expect privacy, and so it is generally acceptable to observe without participant consent. In places that people perceive as private, which can include a church,

**Eliminating Bias in Your Observation Notes**

The ethical concern of being unbiased is important in recording your observations. You need to be aware of the difference between an observation (recording exactly what you see) and an interpretation (making assumptions and judgments about what you see). When you observe, you should focus first on only the events that are directly observable. Consider the following two example entries in an observation log:

1. The student sitting in the dining hall enjoys his greasy, oilsoaked pizza. He is clearly oblivious of the calorie content and damage it may do to his body.

2. The student sits in the dining hall. As he eats his piece of pizza, which drips oil, he says to a friend, “This pizza is good.”

**Surveys and Interviews:**

Question Creation Sometimes it is very difficult for a researcher to gain all of the necessary information through observations alone. Along with his observations of the dining halls, Derek wanted to know what students ate in a typical day, and so he used a survey to have them keep track of their eating habits.

Likewise, Jared wanted to learn about writing and communication in engineering and decided to draw upon expert knowledge by asking experienced individuals within the field. Interviews and surveys are two ways that you can gather information about people’s beliefs or behaviors. With these methods, the information you collect is not first-hand (like an observation) but rather “self-reported” data, or data collected in an indirect manner.

William Shadish, Thomas Cook, and Donald Campbell argued that people are inherently biased about how they see the world and may report their own actions in a more favorable way than they may

actually behave. Despite the issues in self-reported data, surveys and interviews are an excellent way to gather data for your primary research project.

Survey or Interview? How do you choose between conducting a survey or an interview? It depends on what kind of information you are looking for.

You shoulduse surveys if you want to learn about a general trend in people's opinions, experiences, and behavior. Surveys are particularly useful to find small amounts of information from a wider selection of people in the hopes of making a general claim. Interviews are best used when you want to learn detailed information from a few specific people. Interviews are also particularly useful if you want to interview experts about their opinions, as Jared did. In sum, use interviews to gain details from a few people, and surveys to learn general patterns from many people.

## Writing Good Questions

One of the greatest challenges in conducting surveys and interviews is writing good questions. As a researcher, you are always trying to eliminate bias, and the questions you ask need to be unbiased and clear. Here are some suggestions on writing good questions:

## Ask about One Thing at a Time

A poorly written question can contain multiple questions, which can confuse participants or lead them to answer only part of the question you are asking. This is called a "double-barreled question" in journalism. The following questions are taken from Jared's research: Poor question: What kinds of problems are being faced in

the field today and where do you see the search for solutions to these problems going?

Revised question #1 : What kinds of problems are being faced in the field today?

Revised question #2: Where do you see the search for solutions to these problems going?

**Understand When to Use Open and Closed Questions**

Closed questions, or questions that have yes/no or other limited responses, should be used in surveys. However, avoid these kinds of questions in interviews because they discourage the interviewee from going into depth.

The question sample above, “Do you believe the economy currently is in a crisis?” could be answered with a simple yes or no, which could keep a participant from talking more about the issue. The “why or why not?” portion of the question asks the participant to elaborate. On a survey, the question “Do you believe the economy currently is in a crisis?”

is a useful question because you can easily count the number of yes and no answers and make a general claim about participant responses.

**Interviews**

Interviews, or question and answer sessions with one or more people, are an excellent way to learn in-depth information from a person for your primary research project. This section presents information on how to conduct a successful interview, including choosing the right person, ways of interviewing, recording your interview, interview locations, and transcribing your interview.

Choosing the Right Person One of the keys to a successful interview is choosing the right person to interview. Think about whom you would like to interview and whom you might know. Do not be afraid to ask people you do not know for interviews. When asking, simply tell them what the interview will beabout, what the interview is for, and how much time it will take. Jared used his Purdue University connection to locate both of the individuals that he ended up interviewing—an advanced Purdue student and a Purdue alum working in an Engineering firm.

**Face-to-Face and Virtual Interviews**

When interviewing, you have a choice of conducting a traditional, face-to-face interview or an interview using technology over the Internet. Face-to-face interviews have the strength that you can ask follow-up questions and use non-verbal communication to your advantage. Individuals are able to say much more in a face-to-face interview than in an email, so you will get more information from a face-to-face interview. However, the Internet provides a host of new possibilities when it comes to interviewing people at a distance. You may choose to do an email interview, where you send questions and ask the person to respond.

You may also choose to use a video or audio conferencing program to talk with the person virtually. If you are choosing any Internet-based option, make sure you have a way of recording the interview. You may also use a chat or instant messaging program to interview your participant—the benefit of this is that you can ask follow-up questions during the interview and the interview is already transcribed for you. Because one of his interviewees lived several hours away, Jared chose to interview the Purdue student faceto-face and the Purdue alum via email.

Transcribing Your Interview Once your interview is over, you will need to transcribe your interview to prepare it for analysis. The term transcribing means creating a written record that is exactly what was said—i.e. typing up your interviews. If you have conducted an email or chat interview, you already have a transcription and can move on to your analysis stage.

**Analyzing and Writing About Primary**

Research Once you collect primary research data, you will need to analyze what you have found so that you can write about it. The purpose of analyzing your data is to look at what you collected (survey responses, interview answers to questions, observations) and to create a cohesive, systematic interpretation to help answer your research question or examine the validity of your hypothesis. When you are analyzing and presenting your findings, remember to work to eliminate bias by being truthful and as accurate as possible about what you found, even if it differs from what you expected to find. You should see your data as sources of information, just like sources you find in the library, and you should work to represent them accurately. The following are suggestions for analyzing different types of data.

**Observations**

If you've counted anything you were observing, you can simply add up what you counted and report the results. If you've collected descriptions using a double-entry notebook, you might work to write thick descriptions of what you observed into your writing. This could include descriptions of the scene, behaviors you observed, and your overall conclusions about events. Be sure that your readers are clear on what were your actual observations versus your thoughts or interpretations of those observations.

## Interviews

If you've interviewed one or two people, then you can use your summary, paraphrasing, and quotation skills to help you accurately describe what was said in the interview. Just like in secondary researchwhen working with sources, you should introduce your interviewees and choose clear and relevant quotes from the interviews to use in your writing. An easy way to find the important information in an interview is to print out your transcription and take a highlighter and mark the important parts that you might use in your paper. If you have conducted a large number of interviews, it will be helpful for you to create a spreadsheet of responses to each question and compare the responses, choosing representative answers for each area you want to describe. Surveys

## Surveys

can contain quantitative (numerical) and qualitative (written answers/descriptions) data. Quantitative data can be analyzed using a spreadsheet program like Microsoft Excel to calculate the mean (average) answer or to calculate the percentage of people who responded in a certain way. You can display this information in a chart or a graph and also describe it in writing in your paper. If you have qualitative responses, you might choose to group them into categories and/or you may choose to quote several representative responses.

## Experimental

Experimental psychology can be defined as the scientific and empirical approach to the study of the mind. The experimental

approach means that tests are administered to participants, with both control and experimental conditions.

This means that a group of participants are exposed to a stimulus (or stimuli), and their behavior in response is recorded. This behavior is compared to some kind of control condition, which could be either a neutral stimulus, the absence of a stimulus, or against a control group.

Experimental psychology is concerned with testing theories of human thoughts, feelings, actions, and beyond – any aspect of being human that involves the mind. This is a broad category that features many branches within it (e.g. behavioral psychology, cognitive psychology). Below, we will go through a brief history of experimental psychology, the aspects that characterize it, and outline research that has gone on to shape this field.

A Brief History of Experimental Psychology

As with anything, and perhaps particularly with scientific ideas, it's difficult to pinpoint the exact moment in which a thought or approach was conceived. One of the best candidates with which to credit the emergence of experimental psychology with is Gustav Fechner who came to prominence in the 1830's. After completing his Ph.D in biology at the University of Leipzig [1], and continuing his work as a professor, he made a significant breakthrough in the conception of mental states.

As Schultz and Schultz recount [2]: "An increase in the intensity of a stimulus, Fechner argued, does not produce a one-to-one increase in the intensity of the sensation … For example, adding the sound of one bell to that of an already ringing bell produces a greater increase in sensation than adding one bell to 10 others already

ringing. Therefore, the effects of stimulus intensities are not absolute but are relative to the amount of sensation that already exists."

The next scientist to advance the field of experimental psychology was influenced directly by reading Fechner's book "Elements of Psychophysics". Hermann Ebbinghaus, also a German scientist, carried out the first properly formalized research into memory and forgetting, by using long lists of (mostly) nonsense syllables (such as: "VAW", "TEL", "BOC") and recording how long it took for people to forget them.

Experiments using this list, concerning learning and memory, would take up much of Ebbinghaus' career, and help cement experimental psychology as a science. There are many other scientists' whose contributions helped pave the way for the direction, approach, and success of experimental psychology (Hermann von Helmholtz, Ernst Weber, and Mary Whiton Calkins, to name just a few), yet their work is beyond the scope of this post.

Defining any scientific field is in itself no exact science – there are inevitably aspects that will be missed. However, experimental psychology features at least three central components that define it: empiricism, falsifiability, and determinism. These features are central to experimental psychology but also many other fields within science.

Empiricism refers to the collection of data that can support or refute a theory. In opposition to purely theoretical reasoning, empiricism is concerned with observations that can be tested. It is based on the notion that all knowledge stems from sensory experience – that observations can be perceived and data surrounding them can be collected to form experiments.

Falsifiability is a foundational aspect of all contemporary scientific work. Karl Popper, a 20th century philosopher, formalized this concept – that for any theory to be scientific there must be a way to falsify it.

## Classic Studies in Experimental Psychology

Little Albert

One of the most notorious studies within experimental psychology was also one of the foundational pieces of research for behaviorism. Popularly known as the study of “Little Albert”, this experiment, carried out in 1920, focused on whether a baby could be made to fear a stimulus through conditioning (conditioning refers to the association of a response to a stimulus) [3].

The psychologist, John B. Watson, devised an experiment in which a baby was exposed to an unconditioned stimulus (in this case, a white rat) at the same time as a fear-inducing stimulus (the loud, sudden sound of a hammer hitting a metal bar). The repetition of this loud noise paired with the appearance of the white rat eventually led to the white rat becoming a conditioned stimulus – inducing the fear response even without the sound of the hammer.

## Asch’s Conformity Experiment

Three decades following Watson’s infamous experiment, beliefs were studied rather than behavior. Research carried out by Solomon Asch in 1951 showed how group pressure could make people say what they didn’t believe.

The goal was to examine how social pressures “induce individuals to resist or to yield to group pressures when the latter are perceived to be contrary to fact” [6]. Participant’s were introduced to a group of

seven people in which, unbeknownst to them, all other individuals were actors hired by Asch. The task was introduced as a perceptual test, in which the length of lines was to be compared.

**The Future of Experimental Psychology**

The majority of this article has been concerned with what experimental psychology is, where it comes from, and what it has achieved so far. An inevitable follow-up question to this is – where is it going?

While predictions are difficult to make, there are at least indications. The best place to look is to experts in the field. Schultz and Schultz refer to modern psychology "as the science of behavior and mental processes instead of only behavior, a science seeking to explain overt behavior and its relationship to mental processes." [2].

The Association for Psychological Science (APS) asked for forecasts from several prominent psychology researchers (original article available here), and received some of the following responses.

## Quasi-Experimental Research

The prefix quasi means "resembling." Thus quasi-experimental research is research that resembles experimental research but is not true experimental research. Although the independent variable is manipulated, participants are not randomly assigned to conditions or orders of conditions (Cook & Campbell, 1979). Because the independent variable is manipulated before the dependent variable is measured, quasi-experimental research eliminates the directionality problem. But because participants are not randomly assigned—making it likely that there are other differences between conditions—quasi-experimental research does not eliminate the

problem of confounding variables. In terms of internal validity, therefore, quasi-experiments are generally somewhere between correlational studies and true experiments.

Quasi-experiments are most likely to be conducted in field settings in which random assignment is difficult or impossible. They are often conducted to evaluate the effectiveness of a treatment—perhaps a type of psychotherapy or an educational intervention. There are many different kinds of quasi-experiments, but we will discuss just a few of the most common ones here.

**Nonequivalent Groups Design**

Recall that when participants in a between-subjects experiment are randomly assigned to conditions, the resulting groups are likely to be quite similar. In fact, researchers consider them to be equivalent. When participants are not randomly assigned to conditions, however, the resulting groups are likely to be dissimilar in some ways. For this reason, researchers consider them to be nonequivalent.

Imagine, for example, a researcher who wants to evaluate a new method of teaching fractions to third graders. One way would be to conduct a study with a treatment group consisting of one class of third-grade students and a control group consisting of another class of third-grade students.

This design would be a nonequivalent groups design because the students are not randomly assigned to classes by the researcher, which means there could be important differences between them. For example, the parents of higher achieving or more motivated students might have been more likely to request that their children be assigned to Ms. Williams's class. Or the principal might have

assigned the “troublemakers” to Mr. Jones’s class because he is a stronger disciplinarian. Of course, the teachers’ styles, and even the classroom environments, might be very different and might cause different levels of achievement or motivation among the students. If at the end of the study there was a difference in the two classes’ knowledge of fractions, it might have been caused by the difference between the teaching methods—but it might have been caused by any of these confounding variables.

Of course, researchers using a nonequivalent groups design can take steps to ensure that their groups are as similar as possible. In the present example, the researcher could try to select two classes at the same school, where the students in the two classes have similar scores on a standardized math test and the teachers are the same sex, are close in age, and have similar teaching styles. Taking such steps would increase the internal validity of the study because it would eliminate some of the most important confounding variables. But without true random assignment of the students to conditions, there remains the possibility of other important confounding variables that the researcher was not able to control.

If the average posttest score is better than the average pretest score, then it makes sense to conclude that the treatment might be responsible for the improvement. Unfortunately, one often cannot conclude this with a high degree of certainty because there may be other explanations for why the posttest scores are better. One category of alternative explanations goes under the name of **history**. Other things might have happened between the pretest and the posttest. Perhaps an antidrug program aired on television and many of the students watched it, or perhaps a celebrity died of a drug overdose and many of the students heard about it. Another category of alternative explanations goes under the name

of **maturation**. Participants might have changed between the pretest and the posttest in ways that they were going to anyway because they are growing and learning. If it were a yearlong program, participants might become less impulsive or better reasoners and this might be responsible for the change.

Natural Experiment

Natural experiments are conducted in the everyday (i.e. real life) environment of the participants, but here the experimenter has no control over the independent variable as it occurs naturally in real life.

For example, Hodges and Tizard's attachment research (1989) compared the long term development of children who have been adopted, fostered or returned to their mothers with a control group of children who had spent all their lives in their biological families.

- **Strength**: behavior in a natural experiment is more likely to reflect real life because of its natural setting, i.e. very high ecological validity.
- **Strength**: There is less likelihood of demand characteristics affecting the results, as participants may not know they are being studied.
- **Strength**: Can be used in situations in which it would be ethically unacceptable to manipulate the independent variable, e.g. researching stress.
- **Limitation**: They may be more expensive and time consuming than lab experiments.

- **Limitation**: There is no control over extraneous variables that might bias the results. This makes it difficult for another researcher to replicate the study in exactly the same way.

## Field Study

A field study is a general method for collecting data about users, user needs, and product requirements that involves observation and interviewing. Data are collected about task flows, inefficiencies, and the organizational and physical environments of users.

Investigators in field studies observe users as they work, taking notes on particular activities and often asking questions of the users. Observation may be either direct, where the investigator is actually present during the task, or indirect, where the task is viewed by some other means like a video recorder set up in an office. The method is useful early in product development to gather user requirements. It is also useful for studying currently executed tasks and processes.

## The Focus of Cross-Cultural Psychology

Cross-cultural psychology is a branch of psychology that looks at how cultural factors influence human behavior. While many aspects of human thought and behavior are universal, cultural differences can lead to often surprising differences in how people think, feel, and act.

Some cultures, for example, might stress individualism and the importance of personal autonomy. Other cultures, however, may place a higher value on collectivism and cooperation among

members of the group. Such differences can play a powerful role in many aspects of life.

Cross-cultural psychology is also emerging as an increasingly important topic as researchers strive to understand both the differences and similarities among people of various cultures throughout the world. The International Association of Cross-Cultural Psychology (IACCP) was established in 1972, and this branch of psychology has continued to grow and develop since that time.[1] Today, increasing numbers of psychologists investigate how behavior differs among various cultures throughout the world.

**Why Cross-Cultural Psychology Is Important**

After prioritizing European and North American research for many years, Western researchers began to question whether many of the observations and ideas that were once believed to be universal might apply to cultures outside of these areas. Could their findings and assumptions about human psychology be biased based on the sample from which their observations were drawn?

Cross-cultural psychologists work to rectify many of the biases that may exist in the current research[2] and determine if the phenomena that appear in European and North American cultures also appear in other parts of the world.

For example, consider how something such as social cognition might vary from an individualist culture such as the United States versus a collectivist culture such as China. Do people in China rely on the same social cues as people in the U.S. do? What cultural differences might influence how people perceive each other? These are just some of the questions that a cross-cultural psychologist might explore.

Many cross-cultural psychologists choose to focus on one of two approaches:

- **The etic approach** studies culture through an "outsider" perspective, applying one "universal" set of concepts and measurements to all cultures.
- **The emic approach** studies culture using an "insider" perspective, analyzing concepts within the specific context of the observed culture.

Some cross-cultural psychologists take a combined emic-etic approach.

Meanwhile, some cross-cultural psychologists also study something known as ethnocentrism.

**Ethnocentrism** refers to a tendency to use your own culture as the standard by which to judge and evaluate other cultures.[6] In other words, taking an ethnocentric point of view means using your understanding of your own culture to gauge what is "normal." This can lead to biases and a tendency to view cultural differences as abnormal or in a negative light. It can also make it difficult to see how your own cultural background influences your behaviors.

Psychologists are also concerned with how ethnocentrism can influence the research process. For example, a study might be criticized for having an ethnocentric bias.

Major Topics in Cross-Cultural Psychology

- Emotions
- Language acquisition
- Child development

- Personality
- Social behavior
- Family and social relationships

**Cross-Cultural Psychology Differs From Other Branches of Psychology**

- Many other branches of psychology focus on how parents, friends, and other people impact human behavior, but most do not take into account the powerful impact that culture may have on individual human actions.
- Cross-cultural psychology, on the other hand, is focused on studying human behavior in a way that takes the effects of culture into account.
- According to Walter J. Lonner, writing for Eye on Psi Chi, cross-cultural psychology can be thought of as a type of research methodology rather than an entirely separate field within psychology.

# Phenomenology

Phenomenology is commonly understood in either of two ways: as a disciplinary field in philosophy, or as a movement in the history of philosophy.

The discipline of phenomenology may be defined initially as the study of structures of experience, or consciousness. Literally, phenomenology is the study of “phenomena”: appearances of things, or things as they appear in our experience, or the ways we experience things, thus the meanings things have in our experience. Phenomenology studies conscious experience as experienced from

the subjective or first person point of view. This field of philosophy is then to be distinguished from, and related to, the other main fields of philosophy: ontology (the study of being or what is), epistemology (the study of knowledge), logic (the study of valid reasoning), ethics (the study of right and wrong action), etc.

The historical movement of phenomenology is the philosophical tradition launched in the first half of the 20th century by Edmund Husserl, Martin Heidegger, Maurice Merleau-Ponty, Jean-Paul Sartre, et al. In that movement, the discipline of phenomenology was prized as the proper foundation of all philosophy—as opposed, say, to ethics or metaphysics or epistemology. The methods and characterization of the discipline were widely debated by Husserl and his successors, and these debates continue to the present day. (The definition of phenomenology offered above will thus be debatable, for example, by Heideggerians, but it remains the starting point in characterizing the discipline.)

In recent philosophy of mind, the term “phenomenology” is often restricted to the characterization of sensory qualities of seeing, hearing, etc.: what it is like to have sensations of various kinds. However, our experience is normally much richer in content than mere sensation. Accordingly, in the phenomenological tradition, phenomenology is given a much wider range, addressing the meaning things have in our experience, notably, the significance of objects, events, tools, the flow of time, the self, and others, as these things arise and are experienced in our “life-world”.

Phenomenology as a discipline has been central to the tradition of continental European philosophy throughout the 20th century, while philosophy of mind has evolved in the Austro-Anglo-American tradition of analytic philosophy that developed throughout the

20th century. Yet the fundamental character of our mental activity is pursued in overlapping ways within these two traditions. Accordingly, the perspective on phenomenology drawn in this article will accommodate both traditions. The main concern here will be to characterize the discipline of phenomenology, in a contemporary purview, while also highlighting the historical tradition that brought the discipline into its own.

**The Discipline of Phenomenology**

The discipline of phenomenology is defined by its domain of study, its methods, and its main results.

Phenomenology studies structures of conscious experience as experienced from the first-person point of view, along with relevant conditions of experience. The central structure of an experience is its intentionality, the way it is directed through its content or meaning toward a certain object in the world.

We all experience various types of experience including perception, imagination, thought, emotion, desire, volition, and action. Thus, the domain of phenomenology is the range of experiences including these types (among others). Experience includes not only relatively passive experience as in vision or hearing, but also active experience as in walking or hammering a nail or kicking a ball. (The range will be specific to each species of being that enjoys consciousness; our focus is on our own, human, experience. Not all conscious beings will, or will be able to, practice phenomenology, as we do.)

Conscious experiences have a unique feature: we experience them, we live through them or perform them. Other things in the world we may observe and engage. But we do not experience them, in the

sense of living through or performing them. This experiential or first-person feature—that of being experienced—is an essential part of the nature or structure of conscious experience: as we say, “I see / think / desire / do …” This feature is both a phenomenological and an ontological feature of each experience: it is part of what it is for the experience to be experienced (phenomenological) and part of what it is for the experience to be (ontological).

**From Phenomena to Phenomenology**

The Oxford English Dictionary presents the following definition: “Phenomenology. a. The science of phenomena as distinct from being (ontology). b. That division of any science which describes and classifies its phenomena. From the Greek phainomenon, appearance.” In philosophy, the term is used in the first sense, amid debates of theory and methodology. In physics and philosophy of science, the term is used in the second sense, albeit only occasionally.

In its root meaning, then, phenomenology is the study of phenomena: literally, appearances as opposed to reality. This ancient distinction launched philosophy as we emerged from Plato’s cave. Yet the discipline of phenomenology did not blossom until the 20th century and remains poorly understood in many circles of contemporary philosophy. What is that discipline? How did philosophy move from a root concept of phenomena to the discipline of phenomenology?

Originally, in the 18th century, “phenomenology” meant the theory of appearances fundamental to empirical knowledge, especially sensory appearances. The Latin term “Phenomenologia” was introduced by Christoph Friedrich Oetinger in 1736. Subsequently, the German term “Phänomenologia” was used by Johann Heinrich

Lambert, a follower of Christian Wolff. Immanuel Kant used the term occasionally in various writings, as did Johann Gottlieb Fichte. In 1807, G. W. F. Hegel wrote a book titled Phänomenologie des Geistes (usually translated as Phenomenology of Spirit). By 1889 Franz Brentano used the term to characterize what he called "descriptive psychology". From there Edmund Husserl took up the term for his new science of consciousness, and the rest is history.

**The History and Varieties of Phenomenology**

Phenomenology came into its own with Husserl, much as epistemology came into its own with Descartes, and ontology or metaphysics came into its own with Aristotle on the heels of Plato. Yet phenomenology has been practiced, with or without the name, for many centuries. When Hindu and Buddhist philosophers reflected on states of consciousness achieved in a variety of meditative states, they were practicing phenomenology. When Descartes, Hume, and Kant characterized states of perception, thought, and imagination, they were practicing phenomenology. When Brentano classified varieties of mental phenomena (defined by the directedness of consciousness), he was practicing phenomenology.

When William James appraised kinds of mental activity in the stream of consciousness (including their embodiment and their dependence on habit), he too was practicing phenomenology. And when recent analytic philosophers of mind have addressed issues of consciousness and intentionality, they have often been practicing phenomenology. Still, the discipline of phenomenology, its roots tracing back through the centuries, came to full flower in Husserl.

Husserl's work was followed by a flurry of phenomenological writing in the first half of the 20$^{th}$ century. The diversity of traditional

phenomenology is apparent in the Encyclopedia of Phenomenology (Kluwer Academic Publishers, 1997, Dordrecht and Boston), which features separate articles on some seven types of phenomenology.

(1) Transcendental constitutive phenomenology studies how objects are constituted in pure or transcendental consciousness, setting aside questions of any relation to the natural world around us.

(2) Naturalistic constitutive phenomenology studies how consciousness constitutes or takes things in the world of nature, assuming with the natural attitude that consciousness is part of nature.

(3) Existential phenomenology studies concrete human existence, including our experience of free choice or action in concrete situations.

(4) Generative historicist phenomenology studies how meaning, as found in our experience, is generated in historical processes of collective experience over time.

(5) Genetic phenomenology studies the genesis of meanings of things within one's own stream of experience.

(6) Hermeneutical phenomenology studies interpretive structures of experience, how we understand and engage things around us in our human world, including ourselves and others.

(7) Realistic phenomenology studies the structure of consciousness and intentionality, assuming it occurs in a real world that is largely external to consciousness and not somehow brought into being by consciousness.

Phenomenology and Ontology, Epistemology, Logic, Ethics

The discipline of phenomenology forms one basic field in philosophy among others. How is phenomenology distinguished from, and related to, other fields in philosophy?

Traditionally, philosophy includes at least four core fields or disciplines: ontology, epistemology, ethics, logic. Suppose phenomenology joins that list. Consider then these elementary definitions of field:

- Ontology is the study of beings or their being—what is.
- Epistemology is the study of knowledge—how we know.
- Logic is the study of valid reasoning—how to reason.
- Ethics is the study of right and wrong—how we should act.
- Phenomenology is the study of our experience—how we experience.

The domains of study in these five fields are clearly different, and they seem to call for different methods of study.

Philosophers have sometimes argued that one of these fields is “first philosophy”, the most fundamental discipline, on which all philosophy or all knowledge or wisdom rests. Historically (it may be argued), Socrates and Plato put ethics first, then Aristotle put metaphysics or ontology first, then Descartes put epistemology first, then Russell put logic first, and then Husserl (in his later transcendental phase) put phenomenology first.

Consider epistemology. As we saw, phenomenology helps to define the phenomena on which knowledge claims rest, according to modern epistemology. On the other hand, phenomenology itself

claims to achieve knowledge about the nature of consciousness, a distinctive kind of first-person knowledge, through a form of intuition.

Consider logic. As we saw, logical theory of meaning led Husserl into the theory of intentionality, the heart of phenomenology. On one account, phenomenology explicates the intentional or semantic force of ideal meanings, and propositional meanings are central to logical theory. But logical structure is expressed in language, either ordinary language or symbolic languages like those of predicate logic or mathematics or computer systems. It remains an important issue of debate where and whether language shapes specific forms of experience (thought, perception, emotion) and their content or meaning. So there is an important (if disputed) relation between phenomenology and logico-linguistic theory, especially philosophical logic and philosophy of language (as opposed to mathematical logic per se).

Consider ontology. Phenomenology studies (among other things) the nature of consciousness, which is a central issue in metaphysics or ontology, and one that leads into the traditional mind-body problem. Husserlian methodology would bracket the question of the existence of the surrounding world, thereby separating phenomenology from the ontology of the world. Yet Husserl's phenomenology presupposes theory about species and individuals (universals and particulars), relations of part and whole, and ideal meanings—all parts of ontology.

Now consider ethics. Phenomenology might play a role in ethics by offering analyses of the structure of will, valuing, happiness, and care for others (in empathy and sympathy). Historically, though, ethics has been on the horizon of phenomenology. Husserl largely avoided ethics in his major works, though he featured the role of

practical concerns in the structure of the life-world or of Geist (spirit, or culture, as in Zeitgeist), and he once delivered a course of lectures giving ethics (like logic) a basic place in philosophy, indicating the importance of the phenomenology of sympathy in grounding ethics. In Being and Time Heidegger claimed not to pursue ethics while discussing phenomena ranging from care, conscience, and guilt to “fallenness” and “authenticity” (all phenomena with theological echoes). In Being and Nothingness Sartre analyzed with subtlety the logical problem of “bad faith”,

yet he developed an ontology of value as produced by willing in good faith (which sounds like a revised Kantian foundation for morality). Beauvoir sketched an existentialist ethics, and Sartre left unpublished notebooks on ethics. However, an explicitly phenomenological approach to ethics emerged in the works of Emannuel Levinas, a Lithuanian phenomenologist who heard Husserl and Heidegger in Freiburg before moving to Paris. In Totality and Infinity (1961), modifying themes drawn from Husserl and Heidegger, Levinas focused on the significance of the “face” of the other, explicitly developing grounds for ethics in this range of phenomenology, writing an impression

**Phenomenology and Philosophy of Mind**

It ought to be obvious that phenomenology has a lot to say in the area called philosophy of mind. Yet the traditions of phenomenology and analytic philosophy of mind have not been closely joined, despite overlapping areas of interest. So it is appropriate to close this survey of phenomenology by addressing philosophy of mind, one of the most vigorously debated areas in recent philosophy.

The tradition of analytic philosophy began, early in the 20th century, with analyses of language, notably in the works of Gottlob Frege, Bertrand Russell, and Ludwig Wittgenstein. Then in The Concept of Mind (1949) Gilbert Ryle developed a series of analyses of language about different mental states, including sensation, belief, and will. Though Ryle is commonly deemed a philosopher of ordinary language, Ryle himself said The Concept of Mind could be called phenomenology.

In effect, Ryle analyzed our phenomenological understanding of mental states as reflected in ordinary language about the mind. From this linguistic phenomenology Ryle argued that Cartesian mind-body dualism involves a category mistake (the logic or grammar of mental verbs—"believe", "see", etc.—does not mean that we ascribe belief, sensation, etc., to "the ghost in the machine"). With Ryle's rejection of mind-body dualism, the mind-body problem was re-awakened: what is the ontology of mind vis-à-vis body, and how are mind and body related?

René Descartes, in his epoch-making Meditations on First Philosophy (1641), had argued that minds and bodies are two distinct kinds of being or substance with two distinct kinds of attributes or modes: bodies are characterized by spatiotemporal physical properties, while minds are characterized by properties of thinking (including seeing, feeling, etc.).

Centuries later, phenomenology would find, with Brentano and Husserl, that mental acts are characterized by consciousness and intentionality, while natural science would find that physical systems are characterized by mass and force, ultimately by gravitational, electromagnetic, and quantum fields. Where do we find consciousness and intentionality in the quantum-electromagnetic-

gravitational field that, by hypothesis, orders everything in the natural world in which we humans and our minds exist? That is the mind-body problem today. In short, phenomenology by any other name lies at the heart of the contemporary mind-body problem.

## Grounded theory of psychology

Grounded theory is a well-known methodology employed in many research studies. Qualitative and quantitative data generation techniques can be used in a grounded theory study. Grounded theory sets out to discover or construct theory from data, systematically obtained and analysed using comparative analysis. While grounded theory is inherently flexible, it is a complex methodology. Thus, novice researchers strive to understand the discourse and the practical application of grounded theory concepts and processes.

Glaser and Strauss are recognised as the founders of grounded theory. Strauss was conversant in symbolic interactionism and Glaser in descriptive statistics.[8–10] Glaser and Strauss originally worked together in a study examining the experience of terminally ill patients who had differing knowledge of their health status. Some of these suspected they were dying and tried to confirm or disconfirm their suspicions. Others tried to understand by interpreting treatment by care providers and family members. Glaser and Strauss examined how the patients dealt with the knowledge they were dying and the reactions of healthcare staff caring for these patients. Throughout this collaboration, Glaser and Strauss questioned the appropriateness of using a scientific method of verification for this study. During this investigation, they developed the constant comparative method, a key element of grounded theory, while generating a theory of dying first described in Awareness of

Dying (1965). The constant comparative method is deemed an original way of organising and analysing qualitative data.

Glaser and Strauss subsequently went on to write The Discovery of Grounded Theory: Strategy for Qualitative Research (1967). This seminal work explained how theory could be generated from data inductively. This process challenged the traditional method of testing or refining theory through deductive testing. Grounded theory provided an outlook that questioned the view of the time that quantitative methodology is the only valid, unbiased way to determine truths about the world Glaser and Strauss challenged the belief that qualitative research lacked rigour and detailed the method of comparative analysis that enables the generation of theory. After publishing The Discovery of Grounded Theory, Strauss and Glaser went on to write independently, expressing divergent viewpoints in the application of grounded theory methods.

**Objective:**

The aim of this article is to provide a contemporary research framework suitable to inform a grounded theory study.

**Result:**

This article provides an overview of grounded theory illustrated through a graphic representation of the processes and methods employed in conducting research using this methodology. The framework is presented as a diagrammatic representation of a research design and acts as a visual guide for the novice grounded theory researcher.

**Discussion:**

As grounded theory is not a linear process, the framework illustrates the interplay between the essential grounded theory methods and iterative and comparative actions involved. Each of the essential methods and processes that underpin grounded theory are defined in this article.

**Conclusion:**

Rather than an engagement in philosophical discussion or a debate of the different genres that can be used in grounded theory, this article illustrates how a framework for a research study design can be used to guide and inform the novice nurse researcher undertaking a study using grounded theory. Research findings and recommendations can contribute to policy or knowledge development, service provision and can reform thinking to initiate change in the substantive area of inquiry.

**Keywords:** Framework, grounded theory, grounded theory methods, novice researcher, study design

## Focus groups of Psychology

Focus group discussion requires a team consisting of a skilled facilitator and an assistant (Burrows & Kendall, 1997; Krueger, 1994). The facilitator is central to the discussion not only by managing existing relationships but also by creating a relaxed and comfortable environment for unfamiliar participants. Similarly, the assistant's role includes observing non-verbal interactions and the impact of the group dynamics, and documenting the general content of the discussion, thereby supplementing the data (Kitzinger, 1994, 1995). Non-verbal data rely on the behaviour and actions of respondent's pre-focus group discussion, during and post-focus

group discussion. Non-verbal data provide “thicker” descriptions and interpretations compared to the sole use ofverbal data (Fonteyn, Vettese, Lancaster, & Bauer-Wu, 2008). Gorden (1980) outlines four non-verbal communication data sources based on participants’ behaviour reflected by body displacements and postures (kinesics); use of interpersonal space to communicate attitudes (proxemics); temporal speech markers such as gaps, silences, and hesitations (chronemics); and variations in volume, pitch and quality of voice (paralinguistic).

## TYPES OF FOCUS GROUP DISCUSSION

Five types of focus group discussion have been identified in the literature, and a further two are emerging with the growth in access and variety of online platforms.

### Single focus group

The key feature of a single focus group is the interactive discussion of a topic by a collection of all participants and a team of facilitators as one group in one place. This is the most common and classical type of focus group discussion (Morgan, 1996). It has been widely used by both researchers and practitioners across different disciplines (e.g. Lunt & Livingstone, 1996; Morgan, 1996; Wilkinson, 1998).

### Two-way focus group

This format involves using two groups where one group actively discusses a topic, whereas the other observes the first group (Morgan, 1996; Morgan et al., 1998). Usually, this type of focus group is conducted behind a one-way glass. The observing group and the moderator can observe and note the interactions and discussion of the first group without being seen. Hearing what the

other group thinks (or by observing their interactions) often leads the second group to different conclusions than those it may have reached otherwise (Morgan, 1988). Dual moderator focus group | 3.3 Involves two moderators working together, each performing a different role within the same focus group (Krueger & Casey, 2000). The division of roles ensures a smooth progression of the session and ensures that all topics are covered..

**Duelling moderator focus group**

This involves two moderators who purposefully take opposing sides on an issue or topic under investigation (Krueger & Casey, 2000). Proponents believe that the introduction of contrary views to the discussion by the moderators is critical to achieving more in-depth disclosure of data and information (Kamberelis & Dimitriadis, 2005).

**Respondent moderator focus group**

In this type of focus group discussion, researchers recruit some of the participants to take up a temporary role of moderators (Kamberelis & Dimitriadis, 2005). Having one of the participants lead the discussion is thought to impact on the dynamics of the group by influencing participants' answers, thereby increasing the chances of varied and more honest responses.

**Mini focus group**

Researchers are usually faced with a situation where there is a small potential pool of participants and are difficult to reach, yet the research design requires that the topic must be discussed in a group. Under these circumstances, researchers can only convene a small group of between two and five participants (Kamberelis &

Dimitriadis, 2005). Such groups are usually made up of individuals with high level of expertise (Hague, 2002).

## Online focus groups

Online focus groups are not a different type of focus group discussion per se but one borne out of the introduction of the Internet as an adaptation of traditional methods. It is applied within the online environment, using conference calling, chat rooms or other online means (Kamberelis & Dimitriadis, 2005). Online focus groups boast an aura of dynamism, modernity and competitiveness that transcends classic problems with face-to-face focus group discussion (Edmunds, 1999). However, these discussion platforms are only accessible to participants with access to the Internet and are prone to technical problems such as poor or loss of connectivity and failure to capture non-verbal data (Dubrovsky, Kiesler, & Sethna, 1991).

## MATERIALS AND METHODS

Our primary aim was to understand how focus group discussion has been used as a methodological tool in conservation in the last 20 years. Using a stepwise, structured approach, we reviewed the literature on the use of this method in biodiversity, ecology and conservation research. We used a combination of “Focus Group Discussion*” AND “conserv*,” OR “ecology,” OR “biodivers*,” where “*” denotes a wild card to search for alternative word endings, in a search query within the Scopus database

from 1996 to 2016 (accessed on 20th April 2016). A subsequent search using the term “Focus Group” with the other terms was run on 21st April 2017 in the same database. The search returned 438 peer reviewed articles excluding reviews. We screened the titles

and abstracts to identify only those relevant to conservation, biodiversity and ecology. Studies which had focused primarily on soil or water conservation and did not have a direct bearing on biodiversity conservation were discarded. This resulted in 196 peer-reviewed papers. We retrieved all the relevant papers and scanned the full text to check if they specifically used focus group discussion as a method to answer a research question. All studies where the technique was merely mentioned in the introduction or conclusion section were eliminated. We developed a protocol (Appendix S1, Supporting Information) for extracting data from the final list of studies.

## Introducing Narrative Psychology

It may seem obvious to turn towards psychology in order to throw light on these complex questions regarding self and identity. After all, most people are drawn towards the study of psychology because they are interested in the 'human condition', what makes us human, our loves, passions, hates and desires. But most of us find ourselves only a few months into a psychology degree when we realise that we are dealing with very little of this. Instead, you are enmeshed in statistics, principles of learning, cognition, abstract theories and theoretical models, all of which bear very little resemblance to anything you were originally interested in studying. Somewhat ironically, a great deal of contemporary psychology, supposedly an area devoted to the study of human beings, has become a totally 'lifeless' discipline. So where do we look, in the discipline of psychology, if we want to examine these questions of self and identity? In Introducing Narrative Psychology, I suggested four main areas of psychology which address these issues. These included:

i) experimentally based social psychology;

ii) humanistic psychology;

iii) psychoanalytic/ psychodynamic psychology; and

iv) social constructivist approaches. Highlighting the limitations associated with each of these four areas, I opened the way for a new narrative psychology approach which, although influenced by these approaches (especially humanistic and social constructivist), had the potential to avoid the pitfalls endemic within them.

**Narrative as an 'Organising Principle' for Human Life**

But it is not just the fact that people tell stories in making sense of themselves and others. A narrative psychological approach goes far deeper than that. For, central to this approach, is the development of a phenomenological understanding of the unique 'order of meaning' constitutive of human consciousness (see Crossley, 2000a; Polkinghorne, 1988). One of the main features of this 'order of meaning' is the experience of time and temporality. An understanding of temporality associated with the human realm of meaning is entirely different to that encountered in the natural sciences.

This is because the human realm of meaning it is not related to a 'thing' or a 'substance' but to an 'activity' (Polkinghorne, 1988: 4). Everything experienced by human beings is made meaningful, understood and interpreted in relation to the primary dimension of 'activity' which incorporates both 'time' and 'sequence'. In order to define and interpret 'what' exactly has happened on any particular occasion, the sequence of events is of extreme importance. Hence, a valid portrayal of the experience of selfhood necessitates an

understanding of the inextricable connection between temporality and identity.

**Human Experience and Narrative Structure**

Carr (1986) argues that the reality of human experience can be characterised as one which has a narrative or story-telling character (ibid, p.18). What would it be, he asks, to experience life as a 'mere' or 'pure' sequence of isolated events, one thing after another? In order to illustrate his thesis Carr draws upon phenomenological approaches such as Husserl's theory of time consciousness which depicts the way in which humans ordinarily experience time. He basically makes a distinction between three levels of human experience:

passive experience, active experience and experience of self/life. At each of these levels, human experience can be characterised by a complex temporal structure akin to the configuration of the storied form (see also Bruner, 1990; 1991). In the following exploration of human time consciousness, we will look at each of these experiential levels in turn.

Human Life Narratively Configured? In characterising psychological life through the concept of narrative, however, are we not overplaying the significance played by the storied form in human experience? At the level of 'personal' experience, some researchers have argued that although human experience may bear some resemblance to the story,

the idea that it takes on a narrative structure is mistaken. The core of this argument is that the coherent temporal unity lying at the heart of stories (the connection between beginning, middle and end) is something that is not at all intrinsic to real human events, real

selves and real life. As literary theorist Frank Kermode argues, such 'narrative properties cannot be ascribed to the real' (cited in Wood, 1991: 160). The historian Louis Mink argues a similar point: 'Stories are not lived but told … Life has no beginnings, middles and ends...Narrative qualities are transferred from art to life' (cited in Wood, 1991: 161).

Narrative Incoherence and the Breach of Trauma One good example of disruptive traumatising experiences is that of chronic or serious illness. In recent years numerous studies of chronic illness have illustrated the potentially devastating impact they can have on a person's life. This has been characterised as an 'ontological assault' in which some of the most basic, underlying existential assumptions that people hold about themselves and the world are thrown into disarray (Crossley, 2000b; Janoff Bulman, 1992; Kleinman, 1988; Taylor, S., 1989).

**Adapting to Trauma: Stories and Narrative Coherence**

Research into the experience of chronic and serious illness illustrates the way in which our routine, 'lived' sense of time and identity is one of implicit connection and coherence. This sense is severely disrupted in the face of trauma and it is in such contexts that stories become important as a way of rebuilding a sense of connection and coherence. As the recent proliferation of autobiographies (especially in relation to diseases such as cancer and HIV/AIDS) and self-help groups suggests, for people suffering the trauma of illness, storytelling takes on a 'renewed urgency' (Mathieson and Stam, 1995: 284). Of course, such a narrative understanding bears a strong affinity with Freud's work, which equated mental ill health with an 'incoherent story' and narrative

breakdown. From this perspective, psychotherapy constituted an exercise in 'story repair' and, as Spence (1982) argued:

Freud made us aware of the persuasive power of a coherent narrative - in particular of the ways in which an aptly chosen reconstruction can fill the gap between two apparently unrelated events, and in the process, make sense out of nonsense. There seems no doubt but that a well constructed story possesses a kind of narrative truth that is real and immediate and carries an important significance for the process of therapeutic change.

## Conclusion

This paper has aimed to introduce some of the main themes underpinning a narrative approach towards psychology. Drawing on some of dominant theories in this area, it has argued that human life carries within it a narrative structure to the extent that the the individual, at the level of tacit, phenomenological experience, is constantly projecting backwards and forwards in a manner that maintains a sense of coherence, unity, meaningfulness and identity. From this perspective, the characterisation of human experience as one of constant flux, variability and incoherence, as manifest in many discursive and postmodern approaches, fails to take sufficient account of the essential unity and integrity of everyday lived experience. In accordance with this theoretical perspective, it has been argued that the experience of traumatic events such as serious illness are instrumental in facilitating an appreciation of the way in which human life is routinely narratively configured.

This is because the experience of traumatisation often serves to fundamentally disrupt the routine and orderly sense of existence, throwing into radical doubt our taken-for-granted assumptions about time, identity, meaning, and life itself. When this happens, it is

possible to examine the way in which narratives become important in another sense. This is in terms of the way in which they are used to restore a sense of order and connection, and thus to re-establish a semblance of meaning in the life of the individual. Accordingly, narratives of illness are useful because they help to reveal structures or meanings that typically remain implicit or unrecognised, thus potentiating a transformation of life and elevation to another level.

## Case studies in Psychology

Case studies are in-depth investigations of a single person, group, event or community. Typically, data are gathered from a variety of sources and by using several different methods (e.g. observations & interviews).

The case study research method originated in clinical medicine (the case history, i.e. the patient's personal history). In psychology, case studies are often confined to the study of a particular individual.

The information is mainly biographical and relates to events in the individual's past (i.e. retrospective), as well as to significant events which are currently occurring in his or her everyday life.

The case study is not itself a research method, but researchers select methods of data collection and analysis that will generate material suitable for case studies.

Case studies are widely used in psychology and amongst the best known were the ones carried out by Sigmund Freud, including Anna O and Little Hans.

Freud (1909a, 1909b) conducted very detailed investigations into the private lives of his patients in an attempt to both understand and help them overcome their illnesses. Even today case histories are one of the main methods of investigation in abnormal psychology and psychiatry.

This makes it clear that the case study is a method that should only be used by a psychologist, therapist or psychiatrist, i.e. someone with a professional qualification.

There is an ethical issue of competence. Only someone qualified to diagnose and treat a person can conduct a formal case study relating to atypical (i.e. abnormal) behavior or atypical development.

The procedure used in a case study means that the researcher provides a description of the behavior. This comes from interviews and other sources, such as observation.

The client also reports detail of events from his or her point of view. The researcher then writes up the information from both sources above as the case study, and interprets the information.

Strengths of Case Studies

- Provides detailed (rich qualitative) information.
- Provides insight for further research.
- Permitting investigation of otherwise impractical (or unethical) situations.

Case studies allow a researcher to investigate a topic in far more detail than might be possible if they were trying to deal with a large number of research participants (nomothetic approach) with the aim of ‘averaging’.

Because of their in-depth, multi-sided approach case studies often shed light on aspects of human thinking and behavior that would be unethical or impractical to study in other ways.

Research which only looks into the measurable aspects of human behavior is not likely to give us insights into the subjective dimension to experience which is so important to psychoanalytic and humanistic psychologists.

Case studies are often used in exploratory research. They can help us generate new ideas (that might be tested by other methods). They are an important way of illustrating theories and can help show how different aspects of a person's life are related to each other.

The method is therefore important for psychologists who adopt a holistic point of view (i.e. humanistic psychologists).

Limitations of Case Studies

- Lacking scientific rigour and providing little basis for generalization of results to the wider population.
- Researchers' own subjective feeling may influence the case study (researcher bias).
- Difficult to replicate.
- Time-consuming and expensive.
- The volume of data, together with the time restrictions in place, impacted on the depth of analysis that was possible within the available resources.

Because a case study deals with only one person/event/group we can never be sure if the case study investigated is representative of the wider body of "similar" instances. This means the the

conclusions drawn from a particular case may not be transferable to other settings.

Because case studies are based on the analysis of qualitative (i.e. descriptive) data a lot depends on the interpretation the psychologist places on the information she has acquired.

This means that there is a lot of scope for observer bias and it could be that the subjective opinions of the psychologist intrude in the assessment of what the data means.

For example, Freud has been criticized for producing case studies in which the information was sometimes distorted to fit the particular theories about behavior).

This is also true of Money's interpretation of the Bruce/Brenda case study (Diamond, 1997) when he ignored evidence that went against his theory.

## Ethnography

**Ethnography**, descriptive study of a particular human society or the process of making such a study. Contemporary ethnography is based almost entirely on fieldwork and requires the complete immersion of the anthropologist in the culture and everyday life of the people who are the subject of his study.

There has been some confusion regarding the terms ethnography and ethnology. The latter, a term more widely used in Europe, encompasses the analytical and comparative study of cultures in general, which in American usage is the academic field known as cultural anthropology (in British usage, social anthropology). Increasingly, however, the distinction between the

two is coming to be seen as existing more in theory than in fact. Ethnography, by virtue of its intersubjective nature, is necessarily comparative. Given that the anthropologist in the field necessarily retains certain cultural biases, his observations and descriptions must, to a certain degree, be comparative. Thus the formulating of generalizations about culture and the drawing of comparisons inevitably become components of ethnography.

The description of other ways of life is an activity with roots in ancient times. Herodotus, the Greek traveler and historian of the 5th century BC, wrote of some 50 different peoples he encountered or heard of, remarking on their laws, social customs, religion, and appearance. Beginning with the age of exploration and continuing into the early 20th century, detailed accounts of non-European peoples were rendered by European traders, missionaries, and, later, colonial administrators. The reliability of such accounts varies considerably, as the Europeans often misunderstood what they saw or had a vested interest in portraying their subjects less than objectively.

Modern anthropologists usually identify the establishment of ethnography as a professional field with the pioneering work of both the Polish-born British anthropologist Bronisław Malinowski in the Trobriand Islands of Melanesia (c. 1915) and the American anthropologist Margaret Mead, whose first fieldwork was in Samoa (1925). Ethnographic fieldwork has since become a sort of rite of passage into the profession of cultural anthropology. Many ethnographers reside in the field for a year or more, learning the local language or dialect and, to the greatest extent possible, participating in everyday life while at the same time maintaining an observer's objective detachment. This method, called participant-observation, while necessary and useful for gaining a thorough

understanding of a foreign culture, is in practice quite difficult. Just as the anthropologist brings to the situation certain inherent, if unconscious, cultural biases, so also is he influenced by the subject of his study. While there are cases of ethnographers who felt alienated or even repelled by the culture they entered, many—perhaps most—have come to identify closely with "their people," a factor that affects their objectivity. In addition to the technique of participant-observation, the contemporary ethnographer usually selects and cultivates close relationships with individuals, known as informants, who can provide specific information on ritual, kinship, or other significant aspects of cultural life. In this process also the anthropologist risks the danger of biased viewpoints, as those who most willingly act as informants frequently are individuals who are marginal to the group and who, for ulterior motives (e.g., alienation from the group or a desire to be singled out as special by the foreigner), may provide other than objective explanations of cultural and social phenomena. A final hazard inherent in ethnographic fieldwork is the ever-present possibility of cultural change produced by or resulting from the ethnographer's presence in the group.

Contemporary ethnographies usually adhere to a community, rather than individual, focus and concentrate on the description of current circumstances rather than historical events. Traditionally, commonalities among members of the group have been emphasized, though recent ethnography has begun to reflect an interest in the importance of variation within cultural systems. Ethnographic studies are no longer restricted to small primitive societies but may also focus on such social units as urban ghettos. The tools of the ethnographer have changed radically since Malinowski's time. While detailed notes are still a mainstay of

fieldwork, ethnographers have taken full advantage of technological developments such as motion pictures and tape recorders to augment their written accounts.

**Ethnomusicology**, field of scholarship that encompasses the study of all world musics from various perspectives. It is defined either as the comparative study of musical systems and cultures or as the anthropological study of music. Although the field had antecedents in the 18th and early 19th centuries, it began to gather energy with the development of recording techniques in the late 19th century.

It was known as comparative musicology until about 1950, when the term ethnomusicology was introduced simultaneously by the Dutch scholar of Indonesian music Jaap Kunst and by several American scholars, including Richard Waterman and Alan Merriam. In the period after 1950, ethnomusicology burgeoned at academic institutions. Several societies and periodicals were founded, the most notable being the Society for Ethnomusicology, which publishes the journal Ethnomusicology. Some ethnomusicologists consider their field to be associated with musicology, while others see the field as related more closely to anthropology.

Among the general characteristics of the field are dependence on field research, which may include the direct study of music performance, and interest in all types of music produced in a society, including folk, art, and popular genres. Among the field's abiding concerns are whether outsiders can validly study another culture's music and what the researcher's obligations are to his informants, teachers, and consultants in colonial and postcolonial contexts. Over time, ethnomusicologists have gradually abandoned the detailed analytical study of music and increased

their focus on the anthropological study of music as a domain of culture. With this shift in emphasis has come greater concern with the study of popular musics as expressions of the relationships between dominant and minority cultures; of music as a reflection of political, social-ethnic, and economic movements; and of music in the context of the cultural meanings of gender. See also anthropology: Ethnomusicology.

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# What is Statistics in Psychology: Measures of Central Tendency and Dispersion. Normal Probability Curve. Parametric [t-test] and Non-parametric tests [Sign Test, Wilcoxon Signed rank test, Mann-Whitney test, Kruskal-Wallis test, Friedman]. Power analysis. Effect size?

**Statistics in Psychology: Measures of Central Tendency and Dispersion. Normal Probability Curve. Parametric [t-test] and Non-parametric tests [Sign Test, Wilcoxon Signed rank test, Mann-Whitney test, Kruskal-Wallis test, Friedman]. Power analysis. Effect size**

**Statistics in Psychology: Measures of Central Tendency and Dispersion.**

The following points highlight the three types of measures of central tendency. The types are: 1. Mean 2. Median 3. Mode

**Type # 1. Mean:**

It is also known as arithmetic mean. It is the ordinary average in Arithmetic.

According to Garrett, **"The arithmetic mean, or more simply the mean, is the sum of the separate scores or measures divided by their number."**

**Calculation of the Mean when Data are Ungrouped:**

In ungrouped data, mean is the sum of separate scores or measures divided by their number. If a man earns Rs. 5, Rs. 6 Rs. 4, Rs. 9 on four successive days his mean of daily wage (Rs. 6) is obtained by dividing the sum of his daily earnings by the number of days he has worked. The formula for the mean (M) of a series of ungrouped measures is: $M = \sum X/N$ (arithmetic mean calculated from ungrouped data).

Where $\sum$ means the "sum of,"

X stands for a score of other measure,

N is the number of measures in the series.

**Calculation of the Mean when Data are Grouped:**

**When data or measures have been grouped into a frequency distribution, the mean may by calculated by a simple formula:**

F stands for the frequency of each class-interval.

X represents the mid-point in each class-interval.

N stands for the total number of frequencies.

**The following example is given for calculating the mean from grouped date:**

In calculating mean we first of all find the mid-point (x) of various class- intervals. After finding x we find the fx. Column fx is found by multiplying the mid-point (x) of each interval by the number of scores (f) on it; the mean (47.4) is then simply the sum of the fx namely, (2607.5) divided by N (55).

This is known as long method of finding the mean.

**Short Method of Finding the Mean:**

The long method of finding the mean gives accurate results but often requires the handling of large numbers and entails tedious calculation. Because of this, short method or the “assumed mean” method has been devised for computing the mean.

**According to this method we shall find the mean as follows:**

Mean = AM + Ci

AM stands for the assumed mean or guessed mean,

C stands for correction in terms of class-interval,

i stands for the length of class-intervals.

Ci stands for fx’/N x 1

**Now, we shall calculate the mean by short method from the following data:**

**The various steps in calculating the mean by the short method may be explained below:**

1. In the first column, write the class-intervals.

2. After writing class-intervals, find the mid-points.

3. Then write the frequency.

4. Assume a mean as near the centre of the distribution as possible and preferably on the interval containing the largest frequency.

5. After assuming the mean, find its deviation in terms of class-interval from the assumed mean in units of interval.

6. Multiply each deviation (x') by its appropriate f, the f opposite to it.

7. Find the algebric sum of the plus and minus of x' and divide the sum by N, number of cases. This gives C, the correction in units of class interval.

8. Multiply C by the interval length (i) to get Ci, the score correction.

9. Add Ci algebraically to the AM. This will give the true mean.

**Advantages of the Mean:**

1. It utilises all the items in a group.

2. It is widely understood and easy to calculate.

3. It can be known even when number of items and their aggregate values are known, but details of the different items are not available.

4. It is always definite,

5. It is capable of further algebraic treatment.

6. It is less subject to chance variation. Hence it is more stable measure of central tendency.

**Limitations of the Mean:**

1. It may not be an actual item in a series.

2. It cannot be computed by merely observing the series, unless the series, is very simple.

3. It is essential to know the actual values of all the items before computing the arithmetic mean, but in the case of median and mode the items on the extreme may be ignored without understanding the values of these measurements.

**There are More Important Things:**

Questioning American Psychology's Commitment to Personal Happiness and Self-esteem While I hope I am still too young to write a retrospective of my career, I find myself reflecting on recurring themes in both my professional career as a practicing and teaching psychologist and my personal life. I hope that the reader will indulge a certain personal focus and use of the personal "I" pronoun even though this is a voice not used much in academic psychology.

My focus in this article is on the commitment in American psychology to the ideal of personal happiness and Self-esteem. While for most Americans these aims seem self-evident, I have grown increasingly uncomfortable with and skeptical of these mostly unquestioned assumptions in my field. I hope that what I have to

say can influence the reader both professionally and personally in their pursuit of academic goals and the right kind of life. I will focus on three primary assumptions made by modern American psychology: first, that human beings should or ought to be happy; second, that we should seek to be free of suffering; and third, that humans beings should (and deserve to) feel good about themselves.

**Healthy People Suffer**

Much of modern psychotherapy sets the goal for a healthy individual to be free of suffering. Measures of mental health are almost always organized as “symptom checklists” which add up negative symptoms (like feelings of unhappiness or anxiety) to give you a score reflecting the “amount” of suffering you areexperiencing. In other words, each symptom of suffering is counted against your mental health. This is universal enough that it must seem to most psychologists to be self-evident that suffering is bad and a sign of poor mental health.

I myself helped create one of these measures and also worked in a clinic that used such a checklist to track the progress of psychotherapy. I was certainly committed to ending the suffering of my clients and believed that problems needed to be fixed so that a person would be free of suffering and problems.

**Feeling Good about Oneself**

is to Encourage Illusory Thinking Perhaps the most provocative of my professional disagreements has to do with theway that we should think of ourselves. American psychology has long had an obsession with positive Self-esteem and working to help psychotherapy patients “feel good about themselves.” This kind of

positive self-image is encouraged regardless of the kind of lifestyle or decisions the person is making in their lives. People are encouraged to think positively of themselves even if they are failing miserably in their relationships, career, and personal lives. One of my colleagues worked at a mental hospital where they treated youth who were convicted of violent sexual assault. Even these youth were taught to love themselves more, disregarding or separating themselves from their horrific behavior. I believe that this focus in psychology is counter-productive and I have a feeling that most of us know that it is ultimately wrong. I will explain.

This article throws light upon the fifteen main principles of normal probability curve. Some of the properties are: 1. The normal curve is symmetrical 2. The normal curve is unimodal 3. Mean, median and mode coincide 4. The maximum ordinate occurs at the centre 5. The normal curve is asymptotic to the X-axis 6. The height of the curve declines symmetrically and Others.

**1. The normal curve is symmetrical:**

The Normal Probability Curve (N.P.C.) is symmetrical about the ordinate of the central point of the curve. It implies that the size, shape and slope of the curve on one side of the curve is identical to that of the other.

That is, the normal curve has a bilateral symmetry. If the figure is to be folded along its vertical axis, the two halves would coincide. In other words the left and right values to the middle central point are mirror images.

**2. The normal curve is unimodal:**

Since there is only one point in the curve which has maximum frequency, the normal probability curve is unimodal, i.e. it has only one mode.

## Parametric [t-test] and Non-parametric tests [Sign Test psychology

### PARAMETRIC and NON-PARAMETRIC TESTS

In the literal meaning of the terms, a parametric statistical test is one that makes assumptions about the parameters (defining properties) of the population distribution(s) from which one's data are drawn, while a non-parametric test is one that makes no such assumptions.

### PARAMETRIC TESTS:

Parametric tests normally involve data expressed in absolute numbers or values rather than ranks; an example is the Student's t-test. The parametric statistical test operates under certain conditions. Since these conditions are not ordinarily tested, they are assumed to hold valid. The meaningfulness of the results of a parametric test depends on the validity of the assumption. Proper interpretation of parametric test based on normal distribution also assumes that the scene being analysed results from measurement in at least an interval scale. Let us try to understand the term population. Population refers to the entire group of people which a researcher intends to understand in regard to a phenomenon. The study is generally conducted on a sample of the said population and the obtained results are then applied to the larger population from which the sample was selected.

Tests like t, z, and F are called parametrical statistical tests. T-tests: A T-test is used to determine if the scores of two groups differ on a

single variable. A t-test is designed to test for the differences in mean scores. For instance, you could use t-test to determine whether writing ability differs among students in two classrooms. It may be mentioned here that the parametric tests, namely, t-test and F-test, are considered to be quite robust and are appropriate even when some assumptions are not met.

**Assumptions of Parametric Statistics**

Parametric tests like, 't and f' tests may be used for analysing the data which satisfy the following conditions :

The population from which the sample have been drawn should be normally distributed.

Normal Distributions refer to Frequency distribution following a normal curve, which is infinite at both the ends.

The variables involved must have been measured interval or ratio scale. Variable and its types: characteristic that can have different values.

Types of Variables Dependent Variable: Variable considered to be an effect; usually a measured variable. Independent Variable: Variable considered being a cause. The observation must be independent.

The inclusion or exclusion of any case in the sample should not unduly affect the results of study.

These populations must have the same variance or, in special cases, must have a known ratio of variance. This we call homosedasticity.

The samples have equal or nearly equal variances. This condition is known as equality or homogeneity of variances and is particularly important to determine when the samples are small. The observations are independent.

The selection of one case in the sample is not dependent upon the selection of any other case.

Most of the statistical tests we perform are based on a set of assumptions. When these assumptions are violated the results of the analysis can be misleading or completely erroneous.

**Normality:**

Data have a normal distribution (or at least is symmetric)♣ Homogeneity of variances: Data from multiple groups have the same variance♣ Linearity: Data have a linear relationship♣ Independence: Data are independent♣ We explore in detail what it means for data to be normally distributed in Normal Distribution, but in general it means that the graph of the data has the shape of a bell curve. Such data is symmetric around its mean and has kurtosis equal to zero.

In Testing for Normality and Symmetry we provide tests to determine whether data meet this assumption. Some tests (e.g. ANOVA) require that the groups of data being studied have the same variance. In Homogeneity of Variances we provide some tests for determining whether groups of data have the same variance. Some tests (e.g. Regression) require that there be a linear correlation between the dependent and independent variables. Generally linearity can be tested graphically using scatter diagrams or via other techniques explored in Correlation, Regression and Multiple Regression.

**Introduction:**

The t-test is a basic test that is limited to two groups. For multiple groups, you would have

- to compare each pair of groups. For example with three groups there would be three tests (AB, AC, BC) whilst with seven groups there would be need of 21 tests.

The basic principle is to test the null hypothesis that means of the two groups are equal

**The t-test assumes:**

A normal distribution (parametric data)¬ Underlying variances are equal (if not, use welch's test)¬ It is used when there is random assignment and only two sets of measurement to compare.¬ There are two main types of t-test: Independent – measures – t- test: when samples are not matched.

- Match – pair – t-test: when samples appear in pairs (eg. before and after)

- A single – sample t-test compares a sample against a known figure. For example when measures¬ of a manufactured item are compared against the required standard.

**APPLICATIONS:**

To compare the mean of a sample with population mean. (Simple t-test)

- To compare the mean of one sample with the independent sample. (Independent Sample ttest)

- To compare between the values (readings) of one sample but in two occasions.

(Paired• sample t-test) Independent Samples t-Test (or 2-Sample t-Test) The independent samples t-test is probably the single most widely used test in statistics. It is used to compare differences between separate groups. In Psychology, these groups are often composed by randomly assigning research participants to conditions.

However, this test can also be used to explore differences in naturally occurring groups. For example, we may be interested in differences of emotional intelligence between males and females. Any differences between groups can be explored with the independent t-test, as long as the tested members of each group are reasonably representative of the population.

**NON-PARAMETRIC STASTISTICS** The term non-parametric was first used by Wolfowitz, 1942. To understand the idea of nonparametric statistics it is required to have a basic understanding of parametric statistics which we have already discussed.

A parametric test requires a sample to be normally distributed. A nonparametric test does not rely on parametric assumptions like normality. Nonparametric test create flexible demands of the data. To make standard parametric legitimate, some provisions need to fulfilled, especially for minor sample sizes. For example, the requirement of the one sample t-test is that the observation must be made from ordinarily distributed population. In case, the provision is defined, then the resultants may not be credible. However, in case of Wilcoxon Signed rank test to illustrate valid inference, normality is not required. We can assume that the sampling distribution is normal even if we are not sure that the distribution of the variable in

the population is normal, as long as our sample is large enough, (for example, 100 or more observations). However, if our selected sample is too large, then those teats can only be utilized if we are assured that the variable is disseminated normally. The applications of tests that are based on the normality assumptions are restricted by the deficiency of accurate measurement. For example, a study measures Grade Point Average (GPA) in place of percentage Marks. This measurement scale does not measure the exact distance between the marks of two students. GPA allows us only to rank the students from “good” to “poor” students. This measurement is called the ordinal scale. Statistical techniques such as Analysis of Variance, t-test etc. assume that the data are measured either on interval or ratio scale. In such situations where data is measured on nominal or ordinal scale nonparametric tests are more useful. Thus, nonparametric tests are used when either: Sample is not normally distributed

.• Sample size is small

.• The variables are measured on nominal or ordinal scale.

• There is at least one nonparametric equivalent for each parametric general type of test. Broadly, these tests fall into the following categories: Test of differences between groups (independent samples

• Test of differences ( dependent samples)

• Test of relationships between variables.

• The concepts and procedure to undertake Run Test, Chi-Square Test, Wilcoxon Signed Rank Test, Mann-Whitney Test and Kruskal-Wallis Test are discussed here under: Run Test: Run Test is used to

examine the randomness of data. Many statistical procedures require data to be randomly selected.

Statistics is an Independent branch and its use is highly prevalent in all the fields of knowledge. Many methods and techniques are used in statistics. These have been grouped under parametric and and non-parametric statistics. Statistical tests which are not based on a normal distribution of data or on any other assumption are also known as distribution-free tests and the data are generally ranked or grouped. Examples include the chi-square test and Spearman's rank correlation coefficient.

The first meaning of non-parametric covers techniques that do not rely on data belonging to any particular distribution. These include, among others:

1) Distribution free methods: This means that there are no assumptions that the data have been drawn from a normally distributed population. This consists of non-parametric statistical models, inference and statistical tests.

2) Non-parametric statistics: In this the statistics is based on the ranks of observations and do not depend on any distribution of the population.

3)No assumption of a structure of a model: In non-parametric statistics, the techniques do not assume that the structure of a model is fixed. In this, theindividual variables are typically assumed to belong to parametric distributions, and assumptions about the types of connections among variables are also made. These techniques include, among others:

a) Non-parametric regression

b) Non-parametric hierarchical Bayesian models.

In non-parametric regression, the structure of the relationship is treated nonparametrically. In regard to the Bayesian models, these are based on the Dirichlet process, which allows the number of latent variables to grow as necessary to fit the data. In this the individual variables however follow parametric distributions and even the process controlling the rate of growth of latent variables follows a parametric distribution.

**Assumptions of Parametric Statistics**

Parametric tests like, 't and f' tests may be used for analysing the data which satisfy the following conditions :

The population from which the sample have been drawn should be normally distributed. Normal Distributions refer to Frequency distribution following a normal curve, which is infinite at both the ends.

The variables involved must have been measured interval or ratio scale. Variable and its types:

characteristic that can have different values. Types of Variables Dependent Variable: Variable considered to be an effect; usually a measured variable. Independent Variable: Variable considered being a cause.

The observation must be independent.

The inclusion or exclusion of any case in the sample should not unduly affect the results of study.

These populations must have the same variance or, in special cases, must have a known ratio of variance.

This we call homosedasticity.

The samples have equal or nearly equal variances.

This condition is known as equality or homogeneity of variances and is particularly important to determine when the samples are small. The observations are independent.

The selection of one case in the sample is not dependent upon the selection of any other case.

**Assumptions of Non-parametric Statistics**

We face many situations where we can not meet the assumptions and conditions and thus cannot use parametric statistical procedures. In such situation we are bound to apply non-parametric statistics.

If our sample is in the form of nominal or ordinal scale and the distribution of sample is not normally distributed, and also the sample size is very small, it is always advisable to make use of the non-parametric tests for comparing samples and to make inferences or test the significance or trust worthiness of the computed statistics.

In other words, the use of non-parametric tests is recommended in the following situations: Where sample size is quite small. If the size of the sample is as small as N=5 or N=6, the only alternative is to make use of non-parametric tests.

When assumption like normality of the distribution of scores in the population are doubtful, we use non-parametric tests.

When the measurement of data is available either in the form of ordinal or nominal scales or when the data can be expressed in the

form of ranks or in the shape of + signs or – signs and classification like “good-bad”, etc., we use non-parametric statistics.

## ADVANTAGES OF NON-PARAMETRIC STATISTICS

If the sample size is very small, there may be no alternative except to use a nonparametric statistical test. Non-parametric tests typically make fewer assumptions about the data and may be relevant to a particular situation.

The hypothesis tested by the non-parametric test may be more appropriate for research investigation. Non-parametric statistical tests are available to analyse data which are inherently in ranks as well as data whose seemingly numerical scores have the strength of ranks. For example, in studying a variable such as anxiety,

we may be able to state that subject

A is more anxious than subject B without knowing at all exactly how much more anxious

A is. Thus if the data are inherently in ranks, or even if they can be categorised only as plus or minus (more or less, better or worse), they can be treated by non-parametric methods.

Non-parametric methods are available to treat data which are simply classificatory and categorical, i.e., are measured in nominal scale. Samples made up of observations from several different populations at times cannot be handled by Parametric tests.

Non-parametric statistical tests typically are much easier to learn and to apply than are parametric tests. In addition, their interpretation often is more direct than the interpretation of parametric tests.

## DISADVANTAGES OF NON-PARAMETRIC STATISTICAL TESTS

If all the assumptions of a parametric statistical model are in fact met in the data and the research hypothesis could be tested with a parametric test, then non-parametric statistical tests are wasteful.

The degree of wastefulness is expressed by the power-efficiency of the non-parametric test. It will be remembered that, if a non-parametric statistical test has powerefficiency of say, 90 percent, this means that when all conditions of parametric statistical test are satisfied the appropriate parametric test would be just as effective with a sample which is 10

percent smaller than that used in non-parametric analysis. Another objection to non-parametric statistical test has to do with convenience. Tables necessary to implement non-parametric tests are scattered widely and appear in different formats (The same is true of many parametric tests too).

## Wilcoxon Signed rank Test

## Wilcoxon signed-ranks test

a nonparametric statistical procedure used to determine whether a single sample is derived from a population in which the median equals a specified value. The data are values obtained using a ratio scale, each is subtracted from the hypothesized value of the population median, and the difference scores are then ranked. The test takes into account the direction of the differences and gives more weight to large differences than to small differences.

The Wilcoxon test, which can refer to either the Rank Sum test or the Signed Rank test version, is a nonparametric statistical test that

compares two paired groups. The tests essentially calculate the difference between sets of pairs and analyzes these differences to establish if they are statistically significantly different from one another.

## KEY TAKEAWAYS

- The Wilcoxon test is a nonparametric statistical test that compares two paired groups, and comes in two versions the Rank Sum test or the Signed Rank test.
- The goal of the test is to determine if two or more sets of pairs are different from one another in a statistically significant manner.
- Both versions of the model assume that the pairs in the data come from dependent populations, i.e. following the same person or share price through time or place.

The Basics of the Wilcoxon Test

The Rank Sum and Signed Rank tests were both proposed by American statistician Frank Wilcoxon in a groundbreaking research paper published in 1945. The tests laid the foundation for hypothesis testing of nonparametric statistics, which are used for population data that can be ranked but do not have numerical values, such as customer satisfaction or music reviews. Nonparametric distributions do not have parameters and cannot be defined by an equation as parametric distributions can.

The types of questions that the Wilcoxon Test can help us answer include things like:

- Are test scores different from 5th grade to 5th grade for the same students?

- Does a particular drug have an effect on health when tested on the same individuals?

These models assume that the data comes from two matched, or dependent, populations, following the same person or stock through time or place. The data is also assumed to be continuous as opposed to discrete. Because it is a non-parametric test it does not require a particular probability distribution of the dependent variable in the analysis.

Versions of the Wilcoxon Test

- The Wilcoxon Rank Sum test can be used to test the null hypothesis that two populations have the same continuous distribution. The base assumptions necessary to employ this method of testing is that the data are from the same population and are paired, the data can be measured on at least an interval scale, and the data were chosen randomly and independently.
- The Wilcoxon Signed Rank test assumes that there is information in the magnitudes and signs of the differences between paired observations. As the nonparametric equivalent of the paired student's t-test, the Signed Rank can be used as an alternative to the t-test when the population data does not follow a normal distribution.

Calculating a Wilcoxon Test Statistic

The steps for arriving at a Wilcoxon Signed-Ranks Test Statistic, W, are as follows:

1. For each item in a sample of n items, obtain a difference score $D_i$ between two measurements (i.e., subtract one from the other).
2. Neglect then positive or negative signs and obtain a set of n absolute differences $|D_i|$.
3. Omit difference scores of zero, giving you a set of n non-zero absolute difference scores, where n' ≤ n. Thus, n' becomes the actual sample size.
4. Then, assign ranks $R_i$ from 1 to n to each of the $|D_i|$ such that the smallest absolute difference score gets rank 1 and the largest gets rank n. If two or more $|D_i|$ are equal, they are each assigned the average rank of the ranks they would have been assigned individually had ties in the data not occurred.
5. Now reassign the symbol "+" or "–" to each of the n ranks $R_i$, depending on whether Di was originally positive or negative.
6. The Wilcoxon test statistic W is subsequently obtained as the sum of the positive ranks.

In practice, this test is easily performed using statistical analysis software or a spreadsheet.

The **Wilcoxon signed rank test** (also called the Wilcoxon signed rank sum test) is a non-parametric test. When the word "non-parametric" is used in stats, it doesn't quite mean that you know nothing about the population. It usually means that you know the population data does not have a normal distribution. The Wilcoxon signed rank test should be used if the differences between pairs of data are non-normally distributed.

Two slightly different versions of the test exist:

- The **Wilcoxon signed rank test** compares your sample median against a hypothetical median.
- The **Wilcoxon matched-pairs signed rank test** computes the difference between each set of matched pairs, then follows the same procedure as the signed rank test to compare the sample against some median.

The term "Wilcoxon" is often used for either test. This usually isn't confusing, as it should be obvious if the data is matched, or not matched.

The null hypothesis for this test is that the medians of two samples are equal. It is generally used:

## Mann-Whitney test

It is generally recognized that psychological studies often involve small samples. For example, researchers in clinical psychology often have to deal with small samples that generally include less than 15 participants (Kazdin 2003; Shapiro & Shapiro, 1983; Kraemer, 1981; Kazdin, 1986). Although the researchers aim at collecting large normally distributed samples, they rarely have the appropriate amount of resources (time and money) to recruit a sufficient number of participants. It is thus useful, particularly in psychology, to consider tests that have few constraints and allow experimenters to test their hypotheses on small and poorly distributed samples.

A lot of studies do not provide very good tests for their hypotheses because their samples have too few participants (for a review of the reviews, see Sedlmeier & Gigerenzer, 1989). Even tough small

samples can be methodologically questionable (e.g. generalization is difficult); they can be useful to infer conclusions on the population if the adequate statistical test is applied.

**The Mann-Whitney**

Hypotheses of the Test The Mann-Whitney U test null hypothesis (H0) stipulates that the two groups come from the same population. In other terms, it stipulates that the two independent groups are homogeneous and have the same distribution. The two variables corresponding to the two groups, represented by two continuous cumulative distributions, are then called stochastically equal.

In this case, the null hypothesis is rejected for values of the test statistic falling into either tail of its sampling distribution (see Figure 1 for a visual illustration). On the other hand, if a one-sided or one-tailed test is required, the alternative hypothesis suggests that the variable of one group is stochastically larger than the other group, according to the test direction (positive or negative). Here, the null hypothesis is rejected only for values of the test statistic falling into one specified tail of its sampling distribution (see Figure 1 for a visual illustration).

In more specific terms, let one imagine two independent groups that have to be compared. Each group contains a number n of observations. The Mann-Whitney test is based on the comparison of each observation from the first group with each observation from the second group. According to this, the data must be sorted in ascending order. The data from each group are then individually compared together. The highest number of possible paired comparisons is thus:(nxny ), where nx is the number of observations in the first group and ny the number of observations in the second. If the two groups come from the same population, as stipulated by the

null hypothesis, each datum of the first group will have an equal chance of being larger or smaller than each datum of the second group, that is to say a probability p of one half (1/2). In technical terms,

Assumptions of the Test  In order to verify the hypotheses, the sample must meet certain conditions. These conditions can be easily respected. They are of three types:

(a) The two investigated groups must be randomly drawn from the target population.

implies the absence of measurement and sampling errors (Robert et al., 1988). Note that an error of these last types can be involved but must remain small.

(b) Each measurement or observation must correspond to a different participant. In statistical terms, there is independence within groups and mutual independence between groups.

(c) The data measurement scale is of ordinal or continuous type. The observations values are then of ordinal, relative or absolute scale type.

**Computing the Mann-Whithney**

U test using SPSS First of all, one needs to enter the data in SPSS, not forgetting the golden rule which stipulates that each participant's observation must occupy a line. The numbers of the groups are generally 1 and 2, except whenever it is more practical to use other numbers. Following the entry of the data, open a new syntax window and enter the following syntax.

**Discussion**

Like any statistical test, the Mann-Whitney U has forces and weaknesses. In terms of forces, like any non-parametric test, the Mann-Whitney U does not depend on assumptions on the distribution (i.e. one does not need to postulate the data distribution of the target population).

One can also use it when the conditions of normality neither are met nor realisable by transformations. Moreover, one can use it when his sample is small and the data are semi-quantitative or at least ordinal. In short, few constraints apply to this test.

The Mann-Whitney U test is also one of the most powerful non-parametric tests (Landers, 1981), where the statistical power corresponds to the probability of rejecting a false null hypothesis. This test has thus good probabilities of providing statistically significant results when the alternative hypothesis applies to the measured reality.

Even if it is used on average-size samples (between 10 and 20 observations) or with data that satisfy the constraints of the t-test, the Mann-Whitney has approximately 95% of the Student's t-test statistical power (Landers). By comparison with the t-test, the Mann-Whitney U is less at risk to give a wrongfully significant result when there is presence of one or two extreme values in the sample under investigation (Siegel and Castellan, 1988).

the distributions of these populations do not meet the criteria of normality (Zimmerman, 1985). On the other hand, very little statistical power is lost if the Mann-Whitney U test is used instead of the t-test and this, under statistically controlled conditions (Gibbons and Chakraborti, 1991). In addition, the Mann-Whitney U test is, in exceptional circumstances, more powerful than the t-test. Indeed, it is more powerful in the detection of a difference on the extent of the

possible differences between populations' averages than the t-test when a small manpower is associated with a small variance (Zimmerman, 1987). On the other hand, when the sample size is similar or when the smallest manpower has the greatest variance, the t-test is more powerful on all the extent of the possible differences (Zimmerman). Lastly, the Monte Carlo methods showed that the Mann-

Whitney U test can give wrongfully significant results, that is to say the erroneous acceptance of the alternative hypothesis (Robert & Casella, 2004). This type of results is at risk to be obtained whenever one's samples are drawn from two populations with a same average but with different variances.

In this type of situations, it is largely more reliable to use the t-test which gives a possibility for the samples to come from distributions with different variances. The alpha (α) error or of type I is to reject H0 whereas this one is true. This error is thus amplified when Mann-Whitney U is applied in a situation of heteroscedasticity or distinct variances. In addition, some solutions exist to this major problem (see Kasuya, 2001).

## Kruskal wallis anova test in Psychology

The Kruskal-Wallis test is a nonparametric (distribution free) test, and is used when the assumptions of one-way ANOVA are not met. Both the Kruskal-Wallis test and one-way ANOVA assess for significant differences on a continuous dependent variable by a categorical independent variable (with two or more groups). In the ANOVA, we assume that the dependent variable is normally distributed and there is approximately equal variance on the scores

across groups. However, when using the Kruskal-Wallis Test, we do not have to make any of these assumptions. Therefore, the Kruskal-Wallis test can be used for both continuous and ordinal-level dependent variables. However, like most non-parametric tests, the Kruskal-Wallis Test is not as powerful as the ANOVA.

**Null hypothesis:** Null hypothesis assumes that the samples (groups) are from identical populations.

**Alternative hypothesis:** Alternative hypothesis assumes that at least one of the samples (groups) comes from a different population than the others.

**Example questions answered:**

How do test scores differ between the different grade levels in elementary school?

Do job satisfaction scores differ by race?

The distribution of the Kruskal-Wallis test statistic approximates a chi-square distribution, with k-1 degrees of freedom, if the number of observations in each group is 5 or more. If the calculated value of the Kruskal-Wallis test is less than the critical chi-square value, then the null hypothesis cannot be rejected. If the calculated value of Kruskal-Wallis test is greater than the critical chi-square value, then we can reject the null hypothesis and say that at least one of the samples comes from a different population.

The Kruskal Wallis test is the non parametric alternative to the One Way ANOVA. Non parametric means that the test doesn't assume your data comes from a particular distribution. The H test is used when the assumptions for ANOVA aren't met (like the assumption of normality). It is sometimes called the one-way ANOVA on ranks, as

the ranks of the data values are used in the test rather than the actual data points.

The test determines whether the medians of two or more groups are different. Like most statistical tests, you calculate a test statistic and compare it to a distribution cut-off point. The test statistic used in this test is called the **H statistic.** The hypotheses for the test are:

- $H_0$: population medians are equal.
- $H_1$: population medians are not equal.

The Kruskal Wallis test will tell you if there is a significant difference between groups. However, it won't tell you which groups are different. For that, you'll need to run a Post Hoc test.

Examples

1. You want to find out how test anxiety affects actual test scores. The independent variable "test anxiety" has three levels: no anxiety, low-medium anxiety and high anxiety. The dependent variable is the exam score, rated from 0 to 100%.
2. You want to find out how socioeconomic status affects attitude towards sales tax increases. Your independent variable is "socioeconomic status" with three levels: working class, middle class and wealthy. The dependent variable is measured on a 5-point Likert scale from strongly agree to strongly disagree.

**Kruskal-Wallis H Test**

The Kruskal-Wallis test is considered a nonparametric analogue to the paramateric one-way ANOVA presented in Chapter 10. Just as the one-way ANOVA is an extension of the two independent groups t-test, the Kruskal-Wallis test is an extension of the Mann-W hitney

U test. The Kruskal-Wallis test handles k-independent groups of samples. Like the Mann-Whiteny U test, this test uses ranks. The null and alternative hypotheses are stated verbally. For example:
ho: The diet plans A, B and C are equally effective.
h1: At least one of the following is true: A is different from B, A is different from C or B is different from C.

The test statistic for the Kruskal-Wallis H test is obtained through the following steps:

- Rank all the data disregarding group membership, where a rank of "1" is given to the highest score. For observations that are tied (having the same value), compute the average rank and assign this average to each of the tied observations.
- Add up the ranks for each group, designated as **r(i)**, where **i** is the group number..

## Friedman]. Power analysis. Effect size in Psychology

The reporting of accurate and appropriate conclusions is an essential aspect of scientific research, and failure in this endeavor can threaten the progress of cumulative knowledge. This is highlighted by the current reproducibility crisis, and this crisis disproportionately affects fields that use behavioral research methods, as in much lighting research. A sample of general and topic-specific lighting research papers was reviewed for information about sample sizes and statistical reporting.

This highlighted that lighting research is generally underpowered and, given median sample sizes, is unlikely to be able to reveal small effects. Lighting research most commonly uses parametric

statistical tests, but assessment of test assumptions is rarely carried out.

This risks the inappropriate use of statistical tests, potentially leading to type I and type II errors. Lighting research papers also rarely report measures of effect size, and this can hamper cumulative science and power analyses required to determine appropriate sample sizes for future research studies. Addressing the issues raised in this article related to sample sizes, statistical test assumptions, and reporting of effect sizes can improve the evidential value of lighting research.

At the heart of publication bias and the reproducibility crisis is the occurrence of type I errors (false-positive findings) and type II errors (false-negative findings). We use statistical methods in science in an attempt to avoid making claims that in reality may be a type I or type II error. Null hypothesis statistical testing (Hubbard and Ryan 2000) produces a P-value that represents the probability of obtaining the result (or something more extreme) assuming that there was no real effect or difference between the groups or measures being tested (the “null” hypothesis).

The P-value does not explicitly refer to the probability of the null hypothesis being true, but it does provide a “measure of the strength of evidence against $H_0$ (the null hypothesis)” (Dorey 2010, p. 2297). Abelson (1995) referred to “discrediting the null hypothesis” (p. 10) based on the P-value from a statistical test. A smaller P-value provides stronger evidence against the null hypothesis.

By convention, in the field of lighting research and most other scientific disciplines, we use a threshold of $P < 0.05$ to indicate a significant or “real” effect, based on proposals by Fisher (1925).

However, Fisher himself recognizedthat this threshold was arbitrary and debate is ongoing about its use. The reproducibility crisis has led some researchers to suggest that a stricter threshold of 0.005 should be used (Benjamin et al. 2017), to reduce the number of type I errors reported in the scientific literature.

**Assessment of normality**

Confirming whether the data collected within a study sufficiently meets the assumption of a normal distribution should be seen as an informed judgment based on a series of diagnostic checks, rather than a definitive black and white decision. Note also that in regression analyses, it is the residuals (errors between the predicted and actual values) that are required to be normally distributed, not the actual variable values themselves. Normality of residuals may also be adequate for between-subjects ANOVAs and independent t-tests (Williams et al. 2013).

Three types of checks should be carried out to perform a comprehensive assessment of normality: (1) visual inspection of graphical representations of the data; (2) assessment of descriptive statistics; and (3) statistical tests of deviation from a normal distribution. These methods are illustrated using two sets of simulated data, representing normal and nonnormal distributions. The normally distributed data have been generated using the “rnorm” function within the R software package (Version 3.4.0, R Core Team 2017), with the parameters of sample size = 100, mean = 5, standard deviation = 1.5. The nonnormal data are based on a positively skewed exGaussian distribution. This type of distribution is frequently found in reaction time data (Palmer et al. 2011), and reaction times are commonly used as a response

measure in lighting research (e.g., Cengiz et al. 2015; Fotios et al. 2017; He et al. 1997).

**Reporting of effect sizes**

When conducting research, we are generally interested in discovering whether our variables of interest have some effect on what we are studying. This effect may relate to a difference between groups; for example, hazard detection rates under different lighting conditions. Alternatively, it may relate to associations between variables; for example, whether outdoor illuminance levels are associated with perceived safety. If applied appropriately (see Section 3), null hypothesis statistical testing and the P-value produced can provide evidence toward an effect being present (or at least that no effect, the null hypothesis, is implausible). As well as knowing whether an effect may be present, we are also interested in how big this effect is—do our variables have a big influence on what we are measuring or only a trivial influence? A range of methods is available to calculate the size of an effect, some of which are listed in Table 4. Measures of effect size often produce a standardized value that allows comparison between studies using different metrics and a consistent "language" of effect magnitudes. Further information about effect sizes and their calculation is available elsewhere (e.g., Cohen 1988, 1992; Lakens 2013; Sullivan and Feinn 2012).

The size of any effect revealed within a study is a valuable piece of information when results are reported, for three reasons (Lakens 2013). First it provides information about the magnitude of the effect found, allowing its practical importance to be considered. This information cannot be adequately gleaned from only a P-value (Durlak 2009). Second, it can be incorporated into meta-analyses

that combine the findings from multiple studies to provide holistic evidence and more definitive conclusions about a research question or area. Third, it can be used in the design of future related research to estimate required samples sizes, through a priori power analyses, as discussed above. However, despite the evidential and scientific value of reporting effect sizes, this is rarely done in lighting research. The review of recent lighting research papers and papers related to spatial brightness (Section 2) showed that only 24% of the 50 studies included in the review reported effect sizes of some kind, with the majority of effect size measures being $R^2$ values from a linear regression.

## Sample size and power

As discussed in previous sections, key goals of any research study are to discover whether an effect exists (which requires appropriate application of statistical tests; see Section 3) and the magnitude of any effect (which requires the calculation and reporting of a measure of effect size; see Section 4).

The sample size used has implications for both of these objectives. Sample size is an essential determinant of the size of the effect that study will be able to reveal. It also contributes to determining the power of the study—the probability that a significant effect will be revealed through statistical testing when a true effect does really exist (i.e., the probability of avoiding a type II error). Increasing the sample size increases the power of a study, thus making it more able to detect an effect of a smaller size, reducing the likelihood that the null hypothesis will be incorrectly accepted.

## Conclusions

Publication bias and the reproducibility crisis are issues that pose a significant risk to the evidential value of research within a number of fields but particularly within lighting research. At the heart of these issues lies the risk of making type I or type II errors. The statistical methods employed in research are designed to reduce these errors, and their role in determining the presence and importance of any effect is critical to the veracity of published research. This article reviewed a sample of general and topic-specific lighting research papers. The review highlighted the relatively small samples used in behavioral lighting research and the lack of power this introduces. The sample sizes used in most lighting studies may only be capable of revealing medium to large effects.

It is important to consider whether an effect of a certain size is of practical significance. Depending on the specific research area and question being investigated, a small effect size may be insufficiently interesting or noteworthy to warrant investigation, and researchers may only be interested in discovering effects equal to or greater than a certain magnitude. With limited research funding and resources available, the size of an effect that is worth detecting is an important consideration when determining the sample size of a study. Whatever size of effect is judged to be sufficiently large to be of interest, it remains important to justify the sample size used. However, the justification of sample sizes, based on anticipated or targeted effect sizes, was virtually nonexistent within the papers reviewed here.

One possible reason for this absence of sample size justification is that the practice of reporting effect sizes in lighting research papers is not commonplace and therefore it may be difficult to estimate anticipated effect sizes with any confidence. Only 24% of reviewed papers reported any kind of effect size measure. The American

Psychological Association Task Force on Statistical Inference (Wilkinson 1999) states that: "… reporting and interpreting effect sizes in the context of previously reported effects is essential to good research" (p. 599). Increased reporting of effect sizes should be encouraged within lighting research, as should detailed, accurate, and appropriate statistical analysis and reporting. This can help reduce the promotion of unsupported findings within lighting research literature.

## Correlational Analysis: Correlation [Product Moment]

Are stock prices related to the price of gold? Is unemployment related to inflation? Is the amount of money spent on research and development related to a company's net worth? Correlation can answer these questions, and there is no statistical technique more useful or more abused than correlation. Correlation is a statistical method that determines the degree of relationship between two different variables. It is also known as a "bivariate" statistic, with bi- meaning two and variate indicating variable or variance.

The two variables are usually a pair of scores for a person or object. The relationship between any two variables are can vary from strong to weak or none. When a relationship is strong, this means that knowing a person's or object's score on one variable helps to predict their score on the second variable.

In other words, if a person has a high score of variable A (compared to all the other peoples' scores on A, then they are likely to have a high score on variable B (compared to the other peoples' scores on B). The latter would be considered a strong positive correlation.

A correlation coefficient that is close to r = 0.00 (note that the typical correlation coefficient is reported to two decimal places) means knowing a person's score on one variable tells you nothing about their score on the other variable. For example, there might be a zero correlation between the number of letters in a person's last name and the number of miles they drive per day. If you know the number of letters in a last name, it tells you nothing about how many miles they drive per day.

There is no relationship between the two variables; therefore, there is a zero correlation. It is also important to note that there are no hard rules about labeling the size of a correlation coefficient. Statisticians generally do not get excited about a correlation until it is greater than r = 0.30 or less than r = -0.30.

The correlational statistical technique usually accompanies correlational designs. In a correlational design, the experimenter typically has little or no control over the variables to be studied. The variables may be statistically analyzed long after they were initially produced or measured. Such data is called archival. The experimenter no longer has any experimental power to control the gathering of the data.

The data has already been gathered, and the experimenter now has only statistical power in his or her control. Cronbach (1967), an American statistician, stated well the difference between the experimental and correlational techniques, "… the experimentalist [is] an expert puppeteer, able to keep untangled the strands to half-a-dozen independent variables. The correlational psychologist is a mere observer of a play where Nature pulls a thousand strings."

**Correlation: Use and Abuse**

The crux of the nature and the problem with correlation is that, just because two variables are correlated, it does not mean that one variable caused the other. We mentioned earlier of a governor who wanted to supply every parent of a newborn child in his state with a classical CD or tape in order to boost the child's IQ.

The governor supported his decision by citing studies, which have shown a positive relationship between listening to classical music and intelligence. In fact, the controversy has grown to the point where it is referred to as the Mozart Effect. The governor is making at least two false assumptions. First, he is assuming a causal relationship between classical music and intelligence, that is, classical music causes intelligence to rise. However, the technique of correlation does not allow the implication of causation.

**A Warning:**

Correlation Does Not Imply Causation A major caution must be reiterated. Correlation does not imply causation. Because there is a strong positive or strong negative correlation between two variables, this does not mean that one variable is caused by the other variable. As noted previously, many statisticians claim that a strong correlation never implies a cause-effect relationship between two variables.

Yet, there are daily published abuses of the correlational design and statistical technique, not only in newspapers but major scientific journals! A sampling of these misinterpretations follows:

1. Marijuana use and heroin use are positively correlated. Some drug opponents note that heroin use is frequently correlated with marijuana use. Therefore, they reason that stopping marijuana use will stop the use of heroin. Clear-thinking statisticians note that even

a higher correlation is obtained between the drinking of milk in childhood and later adult heroin use. Thus, it is just as absurd to think that if early milk use is banned, subsequent heroin use will be curbed, as it is to suppose that banning marijuana will stop heroin abuse.

2. Milk use is positively correlated to cancer rates. While this is not a popular finding within the milk industry, there is a moderately positive correlation with drinking milk and getting cancer (Paulos, 1990). Could drinking milk cause cancer? Probably not. However, milk consumptionis greater in wealthier countries. In wealthier countries people live longer. Greater longevity means people live long enough to eventually get some type of cancer. Thus, milk and cancer are correlated but drinking milk does not cause cancer (nor does getting cancer cause one to drink more milk).

3. Weekly church attendance is negatively correlated with drug abuse. A recent study demonstrated that adolescents who attended church weekly were much less likely to abuse illegal drugs or alcohol. Does weekly church attendance cause a decrease in drug abuse? If the Federal Government passed a law for mandatory church attendance, would there be a decrease in drug abuse? Probably not, and there might even be an increase in drug abuse. This study is another example of the abuse of the interpretation of the correlational design and statistical analysis. 4. Lead Levels are positively correlated to antisocial behavior.

A 1996 correlational study (Needleman et al.) examined the relationship of lead levels in the bones of 301 children and found that higher levels of lead were associated with higher rates of antisocial behavior. “This is the first rigorous study to demonstrate a significant association between lead and antisocial behavior,” said

one environmental health professor about the study. While the studies authors may have been very excited, the study is still correlational in design and analysis, thus, implications of causation should have been avoided. Perhaps antisocial children have a unique metabolic chemistry such that their bodies do not metabolize lead like normal children. Perhaps lead is not a cause of antisocial behavior but the result of being antisocial.

Therefore, the reduction of lead exposure in early childhood may not reduce antisocial behavior at all. Also, note that there was a statistically “significant” relationship. As you will learn later in this chapter, with large samples (like 301 children in this study) even very weak relationships can be statistically significant with correlational techniques.

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. For example, height and weight are related; taller people tend to be heavier than shorter people.

The relationship isn't perfect. People of the same height vary in weight, and you can easily think of two people you know where the shorter one is heavier than the taller one. Nonetheless, the average weight of people 5'5" is less than the average weight of people 5'6", and their average weight is less than that of people 5'7", etc. Correlation can tell you just how much of the variation in peoples' weights is related to their heights.

Although this correlation is fairly obvious your data may contain unsuspected correlations. You may also suspect there are correlations, but don't know which are the strongest. An intelligent correlation analysis can lead to a greater understanding of your data.

## Techniques in Determining Correlation

There are several different correlation techniques. The Survey System's optional **Statistics Module** includes the most common type, called the Pearson or product-moment correlation. The module also includes a variation on this type called partial correlation. The latter is useful when you want to look at the relationship between two variables while removing the effect of one or two other variables.

Like all statistical techniques, correlation is only appropriate for certain kinds of data. **Correlation works for quantifiable data** in which numbers are meaningful, usually quantities of some sort. It cannot be used for purely categorical data, such as gender, brands purchased, or favorite color.

## Rating Scales

Rating scales are a controversial middle case. The numbers in rating scales have meaning, but that meaning isn't very precise. They are not like quantities. With a quantity (such as dollars), the difference between 1 and 2 is exactly the same as between 2 and 3. With a rating scale, that isn't really the case. You can be sure that your respondents think a rating of 2 is between a rating of 1 and a rating of 3, but you cannot be sure they think it is exactly halfway between. This is especially true if you labeled the mid-points of your scale (you cannot assume "good" is exactly half way between "excellent" and "fair").

Most statisticians say you cannot use correlations with rating scales, because the mathematics of the technique assume the differences between numbers are exactly equal. Nevertheless, many survey researchers do use correlations with rating scales, because the

results usually reflect the real world. Our own position is that you can use correlations with rating scales, but you should do so with care. When working with quantities, correlations provide precise measurements. When working with rating scales, correlations provide general indications.

**Correlation Coefficient**

The main result of a correlation is called the **correlation coefficient** (or "r"). It ranges from -1.0 to +1.0. The closer r is to +1 or -1, the more closely the two variables are related.

If r is close to 0, it means there is no relationship between the variables. If r is positive, it means that as one variable gets larger the other gets larger. If r is negative it means that as one gets larger, the other gets smaller (often called an "inverse" correlation).

While correlation coefficients are normally reported as r = (a value between -1 and +1), squaring them makes then easier to understand. The square of the coefficient (or r square) is equal to the percent of the variation in one variable that is related to the variation in the other. After squaring r, ignore the decimal point. An r of .5 means 25% of the variation is related (.5 squared =.25). An r value of .7 means 49% of the variance is related (.7 squared = .49).

A correlation report can also show a second result of each test - statistical significance. In this case, the significance level will tell you how likely it is that the correlations reported may be due to chance in the form of random sampling error. If you are working with small sample sizes, choose a report format that includes the significance level. This format also reports the sample size.

A key thing to remember when working with correlations is never to assume a correlation means that a change in one variable causes a

change in another. Sales of personal computers and athletic shoes have both risen strongly over the years and there is a high correlation between them, but you cannot assume that buying computers causes people to buy athletic shoes (or vice versa).

The second caveat is that the Pearson correlation technique works best with linear relationships: as one variable gets larger, the other gets larger (or smaller) in direct proportion. It does not work well with curvilinear relationships (in which the relationship does not follow a straight line). An example of a **curvilinear relationship** is age and health care. They are related, but the relationship doesn't follow a straight line. Young children and older people both tend to use much more health care than teenagers or young adults. Multiple regression (also included in the **Statistics Module**) can be used to examine curvilinear relationships, but it is beyond the scope of this article.

## Correlational Analysis: Correlation [Product Moment of Psychology]

An outlier (in correlation analysis) is a data point that does not fit the general trend of your data, but would appear to be a wayward (extreme) value and not what you would expect compared to the rest of your data points. You can detect outliers in a similar way to how you detect a linear relationship, by simply plotting the two variables against each other on a graph and visually inspecting the graph for wayward (extreme) points. You can then either remove or manipulate that particular point as long as you can justify why you did so (there are far more robust methods for detecting outliers in regression analysis). Alternatively, if you cannot justify removing the data point(s), you can run a nonparametric test such as Spearman's

rank-order correlation or Kendall's Tau Correlation instead, which are much less sensitive to outliers. This might be your best approach if you cannot justify removing the outlier. The diagram below indicates what a potential outlier might look like: Outliers can have a very large effect on the line of best fit and the Pearson correlation coefficient, which can lead to very different conclusions regarding your data. This point is most easily illustrated by studying scatterplots of a linear relationship with an outlier included and after its removal, with respect to both the line of best fit and the correlation coefficient. This is illustrated in the diagram below:

The present hypothesis can be stated more specifically as - " The scores of School Environment (SE) test & the scores of Reading Comprehension (RC) test of the students will show the positive correlation '' On the basis of researches done on the effect of SE & RC in English, it has been evident that better the schools and their academic climate with better facilities, the better the scholastic achievement in the students.

The related findings have already been shown in the previous chapter. On the basis of these research evidences, the present directional hypothesis has been framed. With the view to putting this hypothesis to test, Pearson's Product Moment correlation (r) between the scores of SE & the scores of RC in English of the students have been computed.

**Results of Differential Studies**

The hypotheses hereafter are pertaining to see the differences of the means of the variables and the interactional effects on the dependent variables of the varied independent variables. Before anyalysing and testing these hypotheses it was desirable to see the variability of the values found for the dependent variable from the

sample taken. To apply ANOVA for the (2x2x2) factorial design the data were tested for homogeneity of the variance by employing KolmogrovSmirnov Test of Goodness of Fit for the homogeneity of variance.

As per the above table the value of 'D' is less than 0438 which shows the significance limit at .05 level. This clearly shows that the value of ‘D’ does not show significance which indicate that there existed homogeneity of variance ensuring the application of ANOVA and other differential hypotheses.

**Beading Comprehension in English in**

* n in . HYPOTESIS: DH 6 There is no significant difference in Reading Comprehension in English in Boys & Girls." Stated in other words - “No significant difference exists in the scores of Reading comprehension in English in boys and girls." With the view to test the tenability of the hypothesis, the scores of boys & girls separately in Reading Comprehension in English are analysed on the basis of the ‘means’ and 't-values.'

On the strength of the above results, we reject our hypothesis OH* and conclude that there exists a significance difference in Reading Comprehension in English in favour of girls.

“Relatively, School Environment would show the maximum main effect and Anxiety would show the minimum main effect on Reading Comprehension in English whereas Socio-Economic Status would fall in between these two main effects."

**Interpretation and Discussion**

Results obtained in the present chapter shows the significant association of the independent variables viz., Anxiety, Socio-

Economic Status and School Environment with the Reading Comprehension in English of the students of class XI, taken as a dependent variable in the study.

From the three independent variables, taken under the present study, the two variables SES & SE belong to the social variables whereas the Anxiety comes under the psychological variables. Thus, the independent variables cover the socio-psychological variables. The association of all these independent variables on the dependent variable noticed different variations in the findings which needs different and separate interpretations.

**Influence of Psychological Variable on Reading Comprehension in English**

Influence of Anxiety on Reading Comprehension in English The results obtained on IH7 indicate that the Anxiety emerged as the potent source variable interacting with Reading Comprehension in English among the students of class XI. The Anxiety indicates a negative correlation with Reading Comprehension in English (CHi) though the correlation is not significant. These facts could be discussed on the strength of the association of the socio-psychological activities with the members and resources of the schools.

**Rank-Order Correlation using**

The Spearman rank-order correlation coefficient (Spearman's correlation, for short) is a nonparametric measure of the strength and direction of association that exists between two variables measured on at least an ordinal scale. It is denoted by the symbol $r_s$ (or the Greek letter ρ, pronounced rho). The test is used for either ordinal variables or for continuous data that has failed the

assumptions necessary for conducting the Pearson's product-moment correlation. For example, you could use a Spearman's correlation to understand whether there is an association between exam performance and time spent revising; whether there is an association between depression and length of unemployment; and so forth. If you would like some more background information about this test, which does not include instructions for SPSS Statistics, see our more general statistical guide: Spearman's rank-order correlation. Possible alternative tests to Spearman's correlation are Kendall's tau-b or Goodman and Kruskal's gamma.

This "quick start" guide shows you how to carry out a Spearman's correlation using SPSS Statistics. We show you the main procedure to carry out a Spearman's correlation in the Procedure section. First, we introduce you to the assumptions that you must consider when carrying out a Spearman's correlation.

**Assumptions**

When you choose to analyse your data using Spearman's correlation, part of the process involves checking to make sure that the data you want to analyse can actually be analysed using a Spearman's correlation. You need to do this because it is only appropriate to use a Spearman's correlation if your data "passes" three assumptions that are required for Spearman's correlation to give you a valid result. In practice, checking for these three assumptions just adds a little bit more time to your analysis, requiring you to click of few more buttons in SPSS Statistics when performing your analysis, as well as think a little bit more about your data, but it is not a difficult task. These three assumptions are:

- **Assumption #1:** Your two variables should be measured on an **ordinal**, **interval** or **ratio scale**. Examples of **ordinal**

**variables** include Likert scales (e.g., a 7-point scale from "strongly agree" through to "strongly disagree"), amongst other ways of ranking categories (e.g., a 3-pont scale explaining how much a customer liked a product, ranging from "Not very much", to "It is OK", to "Yes, a lot"). Examples of **interval/ratio variables** include revision time (measured in hours), intelligence (measured using IQ score), exam performance (measured from 0 to 100), weight (measured in kg), and so forth. You can learn more about ordinal, interval and ratio variables in our article: Types of Variable.

- **Assumption #2:** Your two variables represent **paired observations**. For example, imagine that you were interested in the relationship between daily cigarette consumption and amount of exercise performed each week. A single paired observation reflects the score on each variable for a single participant (e.g., the daily cigarette consumption of "Participant 1" and the amount of exercise performed each week by "Participant 1"). With 30 participants in the study, this means that there would be 30 paired observations.

- **Assumption #3:** There is a **monotonic relationship** between the two variables. A monotonic relationship exists when either the variables increase in value together, or as one variable value increases, the other variable value decreases. Whilst there are a number of ways to check whether a monotonic relationship exists between your two variables, we suggest creating a scatterplot using SPSS Statistics, where you can plot one variable against the other, and then visually inspect the scatterplot to check for monotonicity. Your scatterplot may look something like one of the following:

Example

A teacher is interested in whether those who do better at English also do better in maths. To test whether this is the case, the teacher records the scores of her 10 students in their end-of-year examinations for both English and maths. Therefore, one variable records the English scores and the second variable records the maths scores for the 10 pupils.

## Partial correlation Psychology

**Partial correlation** is the measure of association between two variables, while controlling or adjusting the effect of one or more additional variables. Partial correlations can be used in many cases that assess for relationship, like whether or not the sale value of a particular commodity is related to the expenditure on advertising when the effect of price is controlled.

### Assumptions

Useful in only small models like the models which involve three or four variables.

Used in only those models which assume a linear relationship.

The data is supposed to be interval in nature.

The residual variables or unmeasured variables are not correlated with any of the variables in the model, except for the one for which these residuals have occurred.

Partial correlation **measures the strength of a relationship between two variables, while controlling for the effect of one or more other variables.** For example, you might want to see if there

is a correlation between amount of food eaten and blood pressure, while controlling for weight or amount of exercise. It's possible to control for multiple variables (called control variables or covariates). However, more than one or two is usually not recommended because the more control variables, the less reliable your test.

**Semi-Partial Correlation**

Semi-partial correlation is almost the same as partial. In fact, many authors use the two terms to mean the same thing. However, others do make the following subtle distinction:

With semi-partial correlation, **the third variable holds constant for either X or Y but not both;** with partial, the third variable holds constant for both X and Y.

For example, the semi partial correlation statistic can tell us the particular part of variance, that a particular independent variable explains. It explains how one specific independent variable affects the dependent variable, while other variables are controlled for to prevent them getting in the way.

To find it, calculate the correlation between the dependent variable and the residual of the prediction of one independent variable by the others.

Example

Suppose we use a set of data (from a 2002 paper from Abdi et al.) which lists three variables over six children. Each child was tested for memory span (Y) and speech rate ($X_2$), and their age was also noted. A correlation statistic was desired which predicts Y (memory span) from $X_1$ and $X_2$ (age and speech rate).

Normally, in a situation where $X_1$ and $X_2$ were independent random variables, we'd find out how important each variable was by computing a squared coefficient of correlation between $X_1$ and $X_2$ and the dependent variable Y. We would know that these squared coefficients of correlation were equal to the square multiple coefficient of correlation. But in a case like ours, $X_1$ and $X_2$ are anything but independent. Speech rate is highly dependent on age, and so using the squared coefficient will count the contributions of each variable several times over.

## Multiple correlation Psychology

In statistics, regression analysis is a method for explanation of phenomena and prediction of future events. In the regression analysis, a coefficient of correlation r between random variables X and Y is a quantitative index of association between these two variables. In its squared form, as a coefficient of determination $r^2$, indicates the amount of variance in the criterion variable Y that is accounted for by the variation in the predictor variable X. In the multiple regression analysis, the set of predictor variables $X_1$, $X_2$, ... is used to explain variability of the criterion variable Y. A multivariate counterpart of the coefficient of determination $r^2$ is the coefficient of multiple determination, $R^2$. The square root of the coefficient of multiple determination is the coefficient of **multiple correlation.**

## Conceptualization of multiple correlation

An intuitive approach to the multiple regression analysis is to sum the squared correlations between the predictor variables and the criterion variable to obtain an index of the over-all relationship between the predictor variables and the criterion variable. However, such a sum is often greater than one, suggesting that simple

summation of the squared coefficients of correlations is not a correct procedure to employ. In fact, a simple summation of squared coefficients of correlations between the predictor variables and the criterion variable is the correct procedure, but only in the special case when the predictor variables are not correlated. If the predictors are related, their inter-correlations must be removed so that only the unique contributions of each predictor toward explanation of the criterion are included.

**Fundamental equation of multiple regression analysis**

Initially, a matrix of correlations R is computed for all variables involved in the analysis. This matrix can be conceptualized as a supermatrix, consisting of the vector of cross-correlations between the predictor variables and the criterion variable c, its transpose c' and the matrix of intercorrelations between predictor variables Rxx.

The fundamental equation of the multiple regression analysis is

$R^2 = c' Rxx^{-1} c.$

The expression on the left side signifies the coefficient of multiple determination (squared coefficient of multiple correlation). The expressions on the right side are the transposed vector of cross-correlations c', the matrix of inter-correlations Rxx to be inverted (cf., matrix inversion), and the vector of cross-correlations, c. The premultiplication of the vector of cross-correlations by its transpose changes the coefficients of correlation into coefficients of determination. The inverted matrix of the inter-correlations removes the redundant variance from the of inter-correlations of the predictor set of variables. These not-redundant cross-correlations are summed to obtain the multiple coefficient of determination $R^2$. The square root of this coefficient is the coefficient of multiple correlation R.

Correlation means association - more precisely it is a measure of the extent to which two variables are related. There are three possible results of a correlational study: a positive correlation, a negative correlation, and no correlation.

 A **positive correlation** is a relationship between two variables in which both variables move in the same direction. Therefore, when one variable increases as the other variable increases, or one variable decreases while the other decreases. An example of positive correlation would be height and weight. Taller people tend to be heavier.

 A **negative correlation** is a relationship between two variables in which an increase in one variable is associated with a decrease in the other. An example of negative correlation would be height above sea level and temperature. As you climb the mountain (increase in height) it gets colder (decrease in temperature).

 A **zero correlation** exists when there is no relationship between two variables. For example their is no relationship between the amount of tea drunk and level of intelligence.

Scattergrams

A correlation can be expressed visually. This is done by drawing a scattergram (also known as a scatterplot, scatter graph, scatter chart, or scatter diagram).

A scattergram is a graphical display that shows the relationships or associations between two numerical variables (or co-variables), which are represented as points (or dots) for each pair of score.

A scattergraph indicates the strength and direction of the correlation between the co-variables.

When you draw a scattergram it doesn't matter which variable goes on the x-axis and which goes on the y-axis.

Remember, in correlations we are always dealing with paired scores, so the values of the 2 variables taken together will be used to make the diagram. Decide which variable goes on each axis and then simply put a cross at the point where the 2 values coincide.

Some uses of Correlations

**Prediction**

- If there is a relationship between two variables, we can make predictions about one from another.

**Validity**

- Concurrent validity (correlation between a new measure and an established measure).

**Reliability**

- Test-retest reliability (are measures consistent).
- Inter-rater reliability (are observers consistent).

**Theory verification**

- Predictive validity.

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## Correlation Coefficients: Determining Correlation Strength

Instead of drawing a scattergram a correlation can be expressed numerically as a coefficient, ranging from -1 to +1. When working with continuous variables, the correlation coefficient to use is Pearson's r.

The correlation coefficient (r) indicates the extent to which the pairs of numbers for these two variables lie on a straight line. Values over zero indicate a positive correlation, while values under zero indicate a negative correlation.

A correlation of –1 indicates a perfect negative correlation, meaning that as one variable goes up, the other goes down. A correlation of +1 indicates a perfect positive correlation, meaning that as one variable goes up, the other goes up.

There is no rule for determining what size of correlation is considered strong, moderate or weak. The interpretation of the coefficient depends on the topic of study.

When studying things that are difficult to measure, we should expect the correlation coefficients to be lower (e.g. above 0.4 to be relatively strong). When we are studying things that are more easier to measure, such as socioeconomic status, we expect higher correlations (e.g. above 0.75 to be relatively strong).)

In these kinds of studies, we rarely see correlations above 0.6. For this kind of data, we generally consider correlations above 0.4 to be relatively strong; correlations between 0.2 and 0.4 are moderate, and those below 0.2 are considered weak.

When we are studying things that are more easily countable, we expect higher correlations. For example, with demographic data, we we generally consider correlations above 0.75 to be relatively strong; correlations between 0.45 and 0.75 are moderate, and those below 0.45 are considered weak.

Correlation vs Causation

Causation means that one variable (often called the predictor variable or independent variable) causes the other (often called the outcome variable or dependent variable).

Experiments can be conducted to establish causation. An experiment isolates and manipulates the independent variable to observe its effect on the dependent variable, and controls the environment in order that extraneous variables may be eliminated.

A correlation between variables, however, does not automatically mean that the change in one variable is the cause of the change in the values of the other variable. A correlation only shows if there is a relationship between variables.

Correlation does not always prove causation as a third variable may be involved. For example, being a patient in hospital is correlated with dying, but this does not mean that one event causes the other, as another third variable might be involved (such as diet, level of exercise).

Strengths of Correlations

**1**. Correlation allows the researcher to investigate naturally occurring variables that maybe unethical or impractical to test experimentally. For example, it would be unethical to conduct an experiment on whether smoking causes lung cancer.

**2**. Correlation allows the researcher to clearly and easily see if there is a relationship between variables. This can then be displayed in a graphical form

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## Limitations of Correlations

**1**. Correlation is not and cannot be taken to imply causation. Even if there is a very strong association between two variables we cannot assume that one causes the other.

For example suppose we found a positive correlation between watching violence on T.V. and violent behavior in adolescence. It could be that the cause of both these is a third (extraneous) variable - say for example, growing up in a violent home - and that both the watching of T.V. and the violent behavior are the outcome of this.

**2**. Correlation does not allow us to go beyond the data that is given. For example suppose it was found that there was an association between time spent on homework (1/2 hour to 3 hours) and number of G.C.S.E. passes (1 to 6). It would not be legitimate to infer from this that spending 6 hours on homework would be likely to generate 12 G.C.S.E. passes.

## Special Correlation Methods: Biserial, Point biserial, tetrachoric, phi coefficient

This procedure calculates estimates, confidence intervals, and hypothesis tests for both the point-biserial and the biserial correlations. The point-biserial correlation is a special case of the product-moment correlation in which one variable is continuous and the other variable is binary (dichotomous).

The categories of the binary variable do not have a natural ordering. For example, the binary variable gender does not have a natural ordering. That is, it does not matter whether the males are coded as a zero or a one. Such variables are often referred to as nominal binary variables.

It is assumed that the continuous data within each group created by the binary variable are normally distributed with equal variances and

possibly different means. The biserial correlation has a different interpretation which is may be explained with an example. Suppose you have a set of bivariate data from the bivariate normal distribution.

The two variables have a correlation sometimes called the product-moment correlation coefficient. Now suppose one of the variables is dichotomized by creating a binary variable that is zero if the original variable is less than a certain variable and one otherwise.

The biserial correlation is an estimate of the original product-moment correlation constructed from the point-biserial correlation. For example, you may want to calculate the correlation between IQ and the score on a certain test, but the only measurement available with whether the test was passed or failed. You could then use the biserial correlation to estimate the more meaningful product-moment correlation.

**Point-Biserial Correlation**

Suppose you want to find the correlation between a continuous random variable Y and a binary random variable X which takes the values zero and one. Assume that n paired observations (Yk, Xk), k are available. If the common product-moment correlation r is calculated from these data, the resulting correlation is called the point-biserial correlation.

**Biserial Correlation**

Suppose you want to find the correlation between a pair of bivariate normal random variables when one has been dichotomized. Sheskin (2011) states that the biserial correlation can be calculated from the point-biserial.

## One or More Continuous Variables and a Binary Variable

The continuous data is in one variable (column) and the binary group identification is in another variable. Each row contains the values for one subject. If multiple continuous variables are selected, a separate analysis is made for each. If the binary variable has more than two levels (unique values), a separate analysis is made for each pair.

## Point-Biserial and Biserial Correlations

This report shows the point-biserial correlation and associated confidence interval and hypothesis test on the first row. It shows the biserial correlation and associated confidence interval and hypothesis test on the second row.

## Type

The type of correlation coefficient shown on this row. Note that, although the names point-biserial and biserial sound similar, these are two different correlations that come from different models.

## Correlation

The computed values of the point-biserial correlation and biserial correlation. Note that since the assignment of the zero and one to the two binary variable categories is arbitrary, the sign of the point-biserial correlation can be ignored. This is not true of the biserial correlation.

Note that the point-biserial correlation demands that the variances are equal but is robust to mild non-normality. On the other hand, the biserial correlation is robust to unequal variances, but demands that the data are normal. This report presents the usual descriptive

statistics. This report displays a brief summary of a linear regression of Y on X.

## RANK ORDER CORRELATIONS

We have learned about Pearson's correlation in earlier unit. The Pearson's correlation is calculated on continuous variables. Pearson's correlation is not advised under two circumstances: one, when the data are in the form of ranks and two, when the assumptions of Pearson's correlation are not followed by the data. In this condition, the application of Pearson's correlations is doubtful.

Under such circumstances, rank-order correlations constitute one of the important options. The ordinal scale data is called as rank-order data. Now let us look at these two aspects, rank-order and assumption of Pearson's correlations, in greater detail.

Rank-Order Data When the data is in rank-order format, then the correlation that can be computed is called as rank order correlations. The rank-order data present the ranks of the individuals or subjects.

The observations are already in the rank order or the rank order is assigned to them. Marks obtained in the unit test will constitute a continuous data. But if only the merit list of the students is displayed then the data is called as rank order data. If the data is in terms of ranks, then Pearson's correlation need not be done. Spearman's rho constitutes a good option.

### Assumptions Underlying Pearson's Correlation not Satisfied

The statistical significance testing of the Pearson's correlation requires some assumptions about the distributional properties of the

variables. We have already delineated these assumptions in the earlier unit. When the assumptions are not followed by the data, then employing the Pearson's correlation is problematic. It should be noted that small violations of the assumptions does not influence the distributional properties and associated probability judgments. Hence it is called as a robust statistics. However, when the assumptions are seriously violated, then application of Pearson's correlation should no longer be considered as a choice. Under such circumstances, Rank order correlations should be preferred over Pearson's correlation.

It needs to be noted that rank-order correlations are applicable under the circumstances when the relationship between two variables is not linear but still it is a monotonic relationship. The monotonic relationship is one where values in the data are consistently increasing and never decreasing or consistently decreasing and never increasing. Hence, monotonic relationship implies that as X increases Y consistently increase or as X increases Y consistently decrease. In such cases, rank-order is a better option than Pearson's correlation coefficient. However, some caution should be observed while doing so.

A careful scrutiny of Figure 1 below indicates that, in reality, it is a power function. So actually a relationship between X and Y is not linear but curvilinear power function. So, indeed, curve-fitting is a best approach for such data than using the rank order correlation. The rank-order can be used with this data since the curvilinear relationship shown in figure 1 is also a monotonic relationship. It must be kept in mind that all curvilinear relationships would not be monotonic relationships.

## THE PHI-COEFFICIENT, THE TETRACHORIC CORRELATION COEFFICIENT, AND THE PEARSON-YULE DEBATE

The phi-coefficient and the tetrachoric correlation coefficient are two measures of association for dichotomous variables. The association between variables is of fundamental interest in most scientific disciplines, and dichotomous variables occur in a wide range of applications.

Consequently, measures of association for dichotomous variables are useful in many situations. For example in medicine, many phenomena can only be reliably measured in terms of dichotomous variables. Another example is psychology, where many conditions only can be reliably measured in terms of, for instance, diagnosed or not diagnosed. Data is often presented in the form of 2 × 2 contingency tables.

A historically prominent example is Pearson's smallpox recovery data, see Table 1, studying possible association between vaccination against, and recovery from, smallpox infection. Another interesting data set is Pearson's diphtheria recovery data, Table 2, studying possible association between antitoxin serum treatment and recovery from diphtheria. Measures of association for dichotomous variables is an area that has been studied from the very infancy of modern statistics. One of the first scholars to treat the subject was Karl Pearson, one of the fathers of modern statistics.

probabilities of the contingency table. The tetrachoric correlation coefficient is then defined as that parameter, which, of course, corresponds to the linear correlation of the bivariate normal distribution.

According to Pearson's colleague Burton H. Camp (1933), Pearson considered the tetrachoric correlation coefficient as being one of his most important contributions to the theory of statistics, right besides his system of continuous curves, the chi-square test and his contributions to small sample statistics. However, the tetrachoric correlation coefficient suffered in popularity because of the difficulty in its computation.

While the tetrachoric correlation coefficient is the linear correlation of a so-called underlying bivariate normal distribution, the phi-coefficient is the linear correlation of an underlying bivariate discrete distribution. This measure of association was independently proposed by Boas (1909), Pearson (1900), Yule (1912), and possibly others. The question of whether the underlying bivariate distribution should be considered continuous or discrete is at the core of the so-called Pearson-Yule debate. In the historical context of the Pearson-Yule debate, though,

it is important to understand that no one at the time looked upon these two measures of association as the linear correlations of different underlying distributions, the framework in which both were presented in the preceding paragraph. On the contrary, according to Yule (1912) the tetrachoric correlation coefficient is founded upon ideas entirely different from those of which the phi-coefficient is founded upon.

The sentiment is echoed by Pearson & Heron (1913), which even claims that the phi-coefficient is not based on a reasoned theory, while at the same time arguing for the soundness of the tetrachoric correlation coefficient. In fact, the point of view that both measures of association are the linear correlations of underlying distributions is one of the contributions of the present article.

## The Pearson-Yule debate

George Udny Yule, a former student of Pearson, favored the approach of an inherently discrete underlying distribution. Yule (1912) is a comprehensive review of the area of measures of association for dichotomous variables, as well as a response to Heron (1911), and contains blunt criticism of Pearson's tetrachoric correlation coefficient.

This standpoint Professor Pearson's assumptions are quite inapplicable, and do not lead to the true correlation between the attributes. But this is not, apparently, the standpoint taken by Professor Pearson himself.

## The phi-coefficient

The phi-coefficient is the linear correlation between postulated underlying discrete univariate distributions of X and Y . Formally, let TX andTY be two mappings such that TXX(Ω) and TY Y (Ω) are both subsets of R. For example, TX could be a + b1{pos.} , for some real constants a and b, 1 being the indicator function. Furthermore, denote TX(pos.) = α, TX(neg.) = β, TY (pos.) = γ and TY (neg.) = δ. The technical conditions α ≠ β, γ ≠ δ and sign(α − β) = sign(γ − δ) are also needed. The phi-coefficient is then defined as the linear correlation of TXX and TY Y , i.e. rphi = Corr(TXX, TY Y ).

## Corollary 2.

Except for its sign, the phi-coefficient does not depend on the choice of mappings TX and TY . An implication of Corollary 2 is that proliferation of phi-coefficients is avoided, and the amount of subjectivism inserted into the phi-coefficient construction is limited. Also, the phi-coefficient can be considered scale and origin free. The only assumption needed is that it is possible to, without loss (or

distortion) of information, map the values of X and Y into R. The assumption is formalized as follows. Assumption A1. The values of the dichotomous variables can without loss of information be mapped into the real ordered field, R.

One possible interpretation of Assumption A1 is that the dichotomous variables X and Y are inherently discrete and that both values of X and Y , respectively, represent the same thing but of different magnitudes. Note that Assumption A1 implies an order relation between the values of X and Y , respectively,

i.e. that the variables are ordinal. Assumption A1 is not appropriate if a dichotomous variable is strictly nominal, e.g. if the values are Male and Female, Cross and Self-Fertilization, or Treatment A and Treatment B. Pearson & Heron (1913) call these cases Mendelian.

**The tetrachoric correlation**

coefficient. The tetrachoric correlation coefficient is the linear correlation between postulated underlying normal distributions of X and Y . The 2×2 contingency table is thought of as a double dichotomy of a bivariate normal distribution. One can visualize the bell-shaped bivariate normal density function standing atop the contingency table. Since the dichotomous variables are both scale and origin free, and the family of normal distributions is closed under linear transformations, the normal distribution can without loss of generality be set to standard normal.

Changing the parameter value of the bivariate standard normal distribution will change the shape of the bell-shaped bivariate normal density function, and hence the probability masses over the four rectangles that results from the double dichotomization.

The parameter value of the bivariate standard normal distribution equals, of course, the linear correlation of the postulated joint normal distributuion. Since the contingency table is fully determined by the marginal probabilities and one joint probability, it suffices to choose parameter value such that, under given marginal probabilities, one joint probability equals the corresponding volume. Conventionally, that joint probability is chosen to be the probability pa, corresponding to positive values of both dichotomous variables. Since a volume of a normal distribution cannot be expressed in closed form, computing the tetrachoric correlation coefficient amounts to solving an integral equation.

There are several theories why Pearson (1900) for the purpose of the above definition chose the parametric family of bivariate normal distributions. At the time, the normal distribution was prevalent, and according to Pearson & Heron (1913) there were no other bivariate distribution that up until the time had been discussed effectively. Furthermore, Pearson (1900) was primarily interested in applications in the fields of evolution and natural selection, which is evident from the article's title, and such variables were generally assumed to be normally distributed.

Pearson's friend and mentor Francis Galton even had a philosophical argument why all variables in nature ought to be normally distributed. Also, the parameter of the parametric family of bivariate normal distributions happens to be a measure of association, and this in combination with other nice properties makes the choice of the bivariate normal distribution most convenient. Ekstr¨om (2009) has generalized the definition so that a large class of parametric families of bivariate distributions can be assumed.

In particular, Assumption A2 implies that the values of the dichotomous variables have an ordering, i.e. that the variables are ordinal. In many of the examples of Pearson (1900), the dichotomous variables are actual dichotomizations of continuous variables such as the stature of fathers and sons.

In practice, however, such variables are most often measured with greater precision than two categories, and for dichotomous variables which cannot be measured with greater precision it is in general not easy to make an assertion about the distribution of a postulated underlying continuous variable. If a tetrachoric correlation coefficient exists and is unique for every contingency table, then the tetrachoric correlation coefficient is said to be well defined. The following theorem is of theoretical and practical importance, and has not been found in the literature.

## Regression: Simple linear regression Psychology

Like correlation, regression also allows you to investigate the relationship between variables. But while correlation is just used to describe this relationship, regression allows you to take things one step further; from description to prediction. Regression allows you to model the relationship between variables, which enables you to make predictions about what one variable will do based on another. Or more specifically, it enables you to predict the value of one variable based on the value of another. The variable you want to predict is called the outcome variable (or DV)

- The variable you will base your prediction on is called the predictor variable

• (or IV) For this tutorial, we will use an example based on a fictional study investigating the people's recovery following brain damage. After a brain injury,

plasticity enables different regions of the brain to compensate for the regions that have been affected; taking over some of the functions that the damaged regions were initially responsible for. However, the extent to which this occurs is dependent on a number of factors. For example, we know that people are much more likely to recover cognitive function if they experience the brain injury when they are young (all other things being equal, such as the severity of the injury,

brain location and so on). So, if we know that brain injury recovery might be related to age, can we predict the degree of brain function someone might expect to recover, based on the age they experienced the injury? This is what we will explore in this tutorial. As with ANOVA, there are different types of regression. But this tutorial will focus on regression in its simplest form: simple linear regression. For simple linear regression, you only have two variables that you are interested in: the predictor (IV) and outcome (DV) variable. In this example our two variables are:

Age – the predictor variable•

Proportion of brain function recovered

the outcome variable• Imagine we carried out a study that measured how much brain function patients recovered following an accident. We could then input it into SPSS (along with their age) as follows:

The final box is the Coefficients table. While the ANOVA table tells us whether the model is a significant predictor of the outcome

variable overall, this table tells us how the individual predictor variables contribute to the model.

This table is most useful in situations where multiple variables have been included as predictors – which is not the case in this example. In this example, given that we only have one predictor variable in our model (Age); and that we know the model is significant, we would expect this table to tell us that Age is a significant predictor of brain function recovery score.

When writing up your results there are certain statistics that you need to report. First, you need to state the proportion of variance that can be explained by• your model. This is represented by the statistic R2 and is a number between 0 and 1. It can either be reported in this format (e.g. R 2 = .872) or it can be multiplied by 100 to represent the percentage of variance your model explains (e.g. 87.2%). Second, you need to report whether or not your model was a significant• predictor of the outcome variable using the results of the ANOVA. Finally, you need to include information about your predictor variables.

In• this case (as there is only one) you need to include your β1 value and the significance of its contribution to the model. While this isn't so important for simple linear regression, when you have multiple predictors you would need to present this information for each variable you have. You might also want to include your final model here. So,

in this case we might say something like: A simple linear regression was carried out to test if age significantly predicted brain function recovery .

**Example of simple linear regression**

The table below shows some data from the early days of the Italian clothing company Benetton. Each row in the table shows Benetton's sales for a year and the amount spent on advertising that year. In this case, our outcome of interest is sales—it is what we want to predict.

If we use advertising as the predictor variable, linear regression estimates that **Sales = 168 + 23 Advertising**.

That is, if advertising expenditure is increased by one million Euro, then sales will be expected to increase by 23 million Euros, and if there was no advertising we would expect sales of 168 million Euros.

**Example of multiple linear regression**

Linear regression with a single predictor variable is known as simple regression. In real-world applications, there is typically more than one predictor variable. Such regressions are called multiple regression. For more information, check out this post on why you should not use multiple linear regression for Key Driver Analysis with example data for multiple linear regression examples.

Returning to the Benetton example, we can include **year** variable in the regression, which gives the result that **Sales = 323 + 14 Advertising + 47 Year.**

**Checking the quality of regression models**

Estimating a regression is a relatively simple thing. The hard bit of using regression is avoiding using a regression that is wrong. Below are standard regression diagnostics for the earlier regression.

The column labelled **Estimate** shows the values used in the equations before. These estimates are also known as

the coefficients and parameters. The **Standard** quantifies the uncertainty of the estimates.

## Multiple regression of Psychology

**Multiple regression** generally explains the relationship between multiple independent or predictor variables and one dependent or criterion variable. A dependent variable is modeled as a function of several independent variables with corresponding coefficients, along with the constant term. Multiple regression requires two or more predictor variables, and this is why it is called multiple regression.

The multiple regression equation explained above takes the following form:

$y = b_1x_1 + b_2x_2 + \ldots + b_nx_n + c.$

Here, $b_i$'s (i=1,2…n) are the regression coefficients, which represent the value at which the criterion variable changes when the predictor variable changes.

As an example, let's say that the test score of a student in an exam will be dependent on various factors like his focus while attending the class, his intake of food before the exam and the amount of sleep he gets before the exam. Using this test one can estimate the appropriate relationship among these factors.

Multiple regression in SPSS is done by selecting "analyze" from the menu. Then, from analyze, select "regression," and from regression select "linear."

**Assumptions**:

- There should be proper specification of the model in multiple regression. This means that only relevant variables must be included in the model and the model should be reliable.
- Linearity must be assumed; the model should be linear in nature.
- Normality must be assumed in multiple regression. This means that in multiple regression, variables must have normal distribution.
- Homoscedasticity must be assumed; the variance is constant across all levels of the predicted variable.

There are certain terminologies that help in understanding multiple regression. These terminologies are as follows:

- **The beta value** is used in measuring how effectively the predictor variable influences the criterion variable, it is measured in terms of standard deviation.
- **R**, is the measure of association between the observed value and the predicted value of the criterion variable. R Square, or $R^2$, is the square of the measure of association which indicates the percent of overlap between the predictor variables and the criterion variable. Adjusted $R^2$ is an estimate of the $R^2$ if you used this model with a new data set.

The regression model was conceptualized in the late nineteenth century by Sir Francis Galton, who was studying how characteristics are inherited from one generation to the next (e.g., Stanton, 2001; Stigler, 1997). Galton's goal was to model and predict the

characteristics of offspring based on the characteristics of their parents.

The term ‘regression’ came from the observation that extreme values (or outliers) in one generation produced offspring that were closer to the mean in the next generation; hence, ‘regression to the mean’occurred (the original terminology used was regression to ‘mediocrity’). Galton also recognized that previous generations (older than the parents) could influence the characteristics of the offspring as well, and this led him to conceptualize the multiple-regression model.

The residuals provide a measure of the goodness or accuracy of the model’s predictions, as smaller (larger) residuals indicate more accurate (inaccurate) predictions. The residuals, εi, are sometimes labeled ‘errors’, but we find this terminology potentially misleading since it connotes that (some of) the variables are subject to measurement error.

In fact, the statistical model assumes implicitly that all measurements are perfectly reliable, and the residuals are due to sampling variance, reflecting the fact that the relationships between Y and the various Xs are probabilistic in nature (e.g., in Galton’s studies, not all boys born to fathers who are 180 cm tall, and mothers who are 164 cm tall, have the same height). The more complex structural equation models (SEM) combine the statistical MR model with measurement models that incorporate the imperfection of the measurement procedures for all the variables involved.

These models are beyond the scope of this chapter, but are covered in Part V (e.g., Chapter 21) of this book. This chapter covers the wide variety of MR applications in behavioral research.

Specifically, we will discuss the measurement, sampling and statistical assumptions of the model, estimation of its parameters, interrelation of its various results, and evaluation of its fit. We illustrate the key results with several numerical examples.

Applications of the multiple-regression model The regression model can be used in one of two general ways, referred to by some (e.g., Pedhazur, 1997) as explanation and prediction. The distinction between these approaches is akin to the distinction between confirmatory and exploratory analyses. The explanatory/confirmatory use of the model seeks to confirm (or refute) certain theoretical expectations and predictions derived from a particular model (typically developed independently of the data at hand).

The ultimate goal is to understand the specific process by which the criterion of interest is produced by the (theoretically determined) predictors. The explanatory regression model is used to confirm the predictions of the theory in the context of a properly formulated model, by using standard statistical tools. It can verify that those predictors that are specified by theory are, indeed, significant and others, which are considered irrelevant by the theory, are not. Similarly, it could test whether the predictor that is postulated by the theory to be the most important in predicting Y reproduces by itself the highest amount of variance, produces the most accurate predictions, and so forth.

Consider, for example, specific theories related to the process and variables that determine an individual's IQ. Some theories may stress the hereditary nature of IQ and others may highlight the environmental components.

Thus, they would have different predictions about the significance and/or relative importance of various predictors in the model. An explanatory application of the model would estimate the model's parameters (e.g., regression coefficients), proceed to test the significance of the relevant predictors, and/or compare the quality and accuracy of the predictions of the various theories.

The predictive/exploratory analysis can be also guided, at least in part, by theory but it is more open ended and flexible and, in particular, relies on the data to direct the analysis. Such an analysis seeks to identify the set of predictors that predicts best the outcome, regardless of whether the model is the 'correct'explanatory mechanism by which the outcome is produced. Of course, it is reassuring if the model makes sense theoretically,

but this is not a must. For example, to predict IQ one would start with a large set of predictors that are theoretically viable and include the predictors that optimally predict the observed values of IQ in the regression model.

Thus, the decision in this case is data driven and more exploratory in nature than the explanatory approach. While the model selected using a prediction approach should yield highly accurate predictions, the components of the model are not considered to be any more 'correct' than those for other potential predictors that would yield the same prediction accuracy.

To borrow an example from Pedhazur (1997), if one is trying to predict the weather, a purely predictive approach is concerned with the accuracy of the prediction regardless of whether the predictors are the true scientific 'causes' of the observed-weather conditions. The explanatory approach, on the other hand, would require a model that can also provide a scientific explanation of how the

predictors produce the observed-weather conditions. Therefore, while the predictive approach may provide accurate predictions of the outcome,

the explanatory approach also provides true knowledge about the processes that underlie and actually produce the outcome. THE VARIOUS FORMS OF THE MODEL Measurement level Typically, all the variables (the response and predictors) are assumed to be quantitative in nature; that is, measured on scales that have well defined and meaningful units (interval or higher).

This assumption justifies the typical interpretation of the regression coefficients as conditional slopes – the expected change in the value of the response variable per unit change of the target predictor, conditional on holding the values of the other (p − 1) predictors fixed. This assumption is also critical for one of the key properties of the MR model. MR is a

compensatory model in the sense that the same response value can be predicted by multiple combinations of the predictors. In particular, high values on some predictors can compensate for low values on others.

**Derivative predictors**

Typically, the p predictors are measured independently from each other by distinct instruments (various scales, different tests, multiple raters, etc.). In some cases, researchers supplement these predictors by additional measures that are derived by specific transformations and/or combinations of the measured variables. For example, polynomial-regression models include successive powers (quadratic, cubic, quartic, etc.) of some of the original predictors, and are designed to capture nonlinear

trends in the relationship between the response and the relevant predictors. Interactive-regression models include variables that are derived by multiplying two, or more, of the measured variables (or some simple transformations of these variables) in an attempt to capture the joint (i.e., above and beyond the additive) effects of the target variables. Computationally,

these models do not require any special treatment as one can treat the product X1X2 or the quadratic term X2 1 as additional variables, but we mention several subtle interpretational issues.

**Sampling designs**

The classical regression model assumes that the values of the predictors are 'fixed'; that is, chosen by various design considerations (including, possibly, plain convenience) rather than sampled randomly. Random samples (of equal, or unequal, size) of the response variable are then obtained for each relevant combination of the p predictors.

Thus, the data consist of a (possibly large) collection of distributions of Y, conditional on particular predetermined combinations of X1,. . ., Xp. The X's (predictors) are not random variables, and their distributions in the sample are not necessarily expected to match their underlying distributions in the population. Thus, no distributional assumptions are madeabout the predictors. The unknown parameters to be estimated in the model are the p regression coefficients and the variance of the residuals. Alternatively, in the 'random' design the researcher randomly samples cases from the population of interest, where a 'case' consists of a vector of all p predictors and the response variable.

The former is a fixed design and the latter is a random one. In both cases one would have the same variables and, subject to minor subtle differences, be able to address the same questions (e.g., Sampson, 1974). In general, the results of a fixed design can be generalized only to the values of X included in the study while the results of a random design can be generalized to the entire population of X values that is represented (by a random sample of values) in the study.

## Factor analysis: Assumptions, Methods, Rotation and Interpretation of psychology

Factor Analysis

**Factor analysis** is a technique that is used to reduce a large number of variables into fewer numbers of factors. This technique extracts maximum common variance from all variables and puts them into a common score. As an index of all variables, we can use this score for further analysis. Factor analysis is part of general linear model (GLM) and this method also assumes several assumptions: there is linear relationship, there is no multicollinearity, it includes relevant variables into analysis, and there is true correlation between variables and factors. Several methods are available, but principal component analysis is used most commonly.

**Types of factoring:**

There are different types of methods used to extract the factor from the data set:

1. **Principal component analysis:** This is the most common method used by researchers. PCA starts extracting the maximum

variance and puts them into the first factor. After that, it removes that variance explained by the first factors and then starts extracting maximum variance for the second factor. This process goes to the last factor.

2. **Common factor analysis:** The second most preferred method by researchers, it extracts the common variance and puts them into factors. This method does not include the unique variance of all variables. This method is used in SEM.

3. **Image factoring:** This method is based on correlation matrix. OLS Regression method is used to predict the factor in image factoring.

4. **Maximum likelihood method:** This method also works on correlation metric but it uses maximum likelihood method to factor.

5. **Other methods of factor analysis:** Alfa factoring outweighs least squares. Weight square is another regression based method which is used for factoring.

**Factor loading:**
Factor loading is basically the correlation coefficient for the variable and factor. Factor loading shows the variance explained by the variable on that particular factor. In the SEM approach, as a rule of thumb, 0.7 or higher factor loading represents that the factor extracts sufficient variance from that variable.
**Eigenvalues:** Eigenvalues is also called characteristic roots. Eigenvalues shows variance explained by that particular factor out of the total variance. From the commonality column, we can know how much variance is explained by the first factor out of the total variance. For example, if our first factor explains 68% variance out of the total, this means that 32% variance will be explained by the

other factor.

**Factor score:** The factor score is also called the component score. This score is of all row and columns, which can be used as an index of all variables and can be used for further analysis. We can standardize this score by multiplying a common term. With this factor score, whatever analysis we will do, we will assume that all variables will behave as factor scores and will move.

**Criteria for determining the number of factors:** According to the Kaiser Criterion, Eigenvalues is a good criteria for determining a factor. If Eigenvalues is greater than one, we should consider that a factor and if Eigenvalues is less than one, then we should not consider that a factor. According to the variance extraction rule, it should be more than 0.7. If variance is less than 0.7, then we should not consider that a factor.

**Rotation method:** Rotation method makes it more reliable to understand the output. Eigenvalues do not affect the rotation method, but the rotation method affects the Eigenvalues or percentage of variance extracted. There are a number of rotation methods available: (1) No rotation method, (2) Varimax rotation method, (3) Quartimax rotation method, (4) Direct oblimin rotation method, and (5) Promax rotation method. Each of these can be easily selected in SPSS, and we can compare our variance explained by those particular methods.

**Assumptions:**

1. **No outlier:** Assume that there are no outliers in data.
2. **Adequate sample size:** The case must be greater than the factor.

3. **No perfect multicollinearity:** Factor analysis is an interdependency technique. There should not be perfect multicollinearity between the variables.
4. **Homoscedasticity:** Since factor analysis is a linear function of measured variables, it does not require homoscedasticity between the variables.
5. **Linearity:** Factor analysis is also based on linearity assumption. Non-linear variables can also be used. After transfer, however, it changes into linear variable.
6. **Interval Data:** Interval data are assumed.

**Key concepts and terms:**

**Exploratory factor analysis:** Assumes that any indicator or variable may be associated with any factor. This is the most common factor analysis used by researchers and it is not based on any prior theory.

**Confirmatory factor analysis (CFA):** Used to determine the factor and factor loading of measured variables, and to confirm what is expected on the basic or pre-established theory. CFA assumes that each factor is associated with a specified subset of measured variables. It commonly uses two approaches:

1. **The traditional method:** Traditional factor method is based on principal factor analysis method rather than common factor analysis. Traditional method allows the researcher to know more about insight factor loading.

2. **The SEM approach:** CFA is an alternative approach of factor analysis which can be done in SEM. In SEM, we will remove all straight arrows from the latent variable, and add only that arrow which has to observe the variable representing the covariance between every pair of latents. We will also leave the straight arrows error free and disturbance terms to their respective variables. If standardized error term in SEM is less than the absolute value two, then it is assumed good for that factor, and if it is more than two, it means that there is still some unexplained variance which can be explained by factor. Chi-square and a number of other goodness-of-fit indexes are used to test how well the model fits.

## Experimental Designs: ANOVA [One-way, Factorial], Randomized Block Designs,

Design of experiment means how to design an experiment in the sense that how the observations or measurements should be obtained to answer a query in a valid, efficient and economical way. The designing of the experiment and the analysis of obtained data are inseparable. If the experiment is designed properly keeping in mind the question, then the data generated is valid and proper analysis of data provides the valid statistical inferences. If the experiment is not well designed, the validity of the statistical inferences is questionable and may be invalid. It is important to understand first the basic terminologies used in the experimental design.

**Experimental unit:**

For conducting an experiment, the experimental material is divided into smaller parts and each part is referred to as an experimental unit. The experimental unit is randomly assigned to treatment is the experimental unit. The phrase “randomly assigned” is very important in this definition.

**Experiment:**

A way of getting an answer to a question which the experimenter wants to know.

**Treatment** Different objects or procedures which are to be compared in an experiment are called treatments.

**Sampling unit:**

The object that is measured in an experiment is called the sampling unit. This may be different from the experimental unit.

**Factor:**

A factor is a variable defining a categorization. A factor can be fixed or random in nature. A factor is termed as a fixed factor if all the levels of interest are included in the experiment.

A factor is termed as a random factor if all the levels of interest are not included in the experiment and those that are can be considered to be randomly chosen from all the levels of interest.

Design of experiment: One of the main objectives of designing an experiment is how to verify the hypothesis in an efficient and economical way. In the contest of the null hypothesis of equality of several means of normal populations having the same variances, the analysis of variance technique can be used. Note that such techniques are based on certain statistical assumptions.

If these assumptions are violated, the outcome of the test of a hypothesis then may also be faulty and the analysis of data may be meaningless. So the main question is how to obtain the data such that the assumptions are met and the data is readily available for the application of tools like analysis of variance. The designing of such a mechanism to obtain such data is achieved by the design of the experiment.

After obtaining the sufficient experimental unit, the treatments are allocated to the experimental units in a random fashion. Design of experiment provides a method by which the treatments are placed at random on the experimental units in such a way that the responses are estimated with the utmost precision possible.

An **ANOVA** test is a way to find out if survey or experiment results are significant. In other words, they help you to figure out if you need to reject the null hypothesis or accept the alternate hypothesis.

Basically, **you're testing groups to see if there's a difference between them.** Examples of when you might want to test different groups:

- A group of psychiatric patients are trying three different therapies: counseling, medication and biofeedback. You want to see if one therapy is better than the others.
- A manufacturer has two different processes to make light bulbs. They want to know if one process is better than the other.
- Students from different colleges take the same exam. You want to see if one college outperforms the other.

What Does "One-Way" or "Two-Way Mean?

**One-way** or **two-way** refers to the number of independent variables (IVs) in your Analysis of Variance test.

- One-way has one independent variable (with 2 levels). For example: brand of cereal,
- Two-way has two independent variables (it can have multiple levels). For example: brand of cereal, calories.

What are “Groups” or “Levels”?

Groups or levels are different groups within the same independent variable. In the above example, your levels for “brand of cereal” might be Lucky Charms, Raisin Bran, Cornflakes — a total of three levels. Your levels for “Calories” might be: sweetened, unsweetened — a total of two levels.

Let’s say you are studying if an alcoholic support group and individual counseling combined is the most effective treatment for lowering alcohol consumption. You might split the study participants into three groups or levels:

- Medication only,
- Medication and counseling,
- Counseling only.

Your dependent variable would be the number of alcoholic beverages consumed per day.

If your groups or levels have a hierarchical structure (each level has unique subgroups), then use a nested ANOVA for the analysis.

What Does “Replication” Mean?

It's whether you are replicating (i.e. duplicating) your test(s) with multiple groups. With a two way ANOVA with replication , you have two groups and individuals within that group are doing more than one thing (i.e. two groups of students from two colleges taking two tests). If you only have one group taking two tests, you would use **without replication.**

**Types of Tests.**

There are two main types: one-way and two-way. Two-way tests can be with or without replication.

- One-way ANOVA between groups: used when you want to test **two groups** to see if there's a difference between them.
- Two way ANOVA without replication: used when you have **one group** and you're **double-testing** that same group. For example, you're testing one set of individuals before and after they take a medication to see if it works or not.
- Two way ANOVA with replication: **Two groups**, and the members of those groups are **doing more than one thing**. For example, two groups of patients from different hospitals trying two different therapies.

**One Way ANOVA**

A one way ANOVA is used to compare two means from two independent (unrelated) groups using the F-distribution. The null hypothesis for the test is that the two means are equal. Therefore, a significant result means that the two means are unequal.

Examples of when to use a one way ANOVA

**Situation 1:** You have a group of individuals randomly split into smaller groups and completing different tasks. For example, you might be studying the effects of tea on weight loss and form three groups: green tea, black tea, and no tea.
**Situation 2:** Similar to situation 1, but in this case the individuals are split into groups based on an attribute they possess. For example, you might be studying leg strength of people according to weight. You could split participants into weight categories (obese, overweight and normal) and measure their leg strength on a weight machine.

## Limitations of the One Way ANOVA

A one way ANOVA will tell you that at least two groups were different from each other. But **it won't tell you which groups were different.** If your test returns a significant f-statistic, you may need to run an ad hoc test (like the Least Significant Difference test) to tell you exactly which groups had a difference in means.

## Two Way ANOVA

A Two Way ANOVA is an extension of the One Way ANOVA. With a One Way, you have one independent variable affecting a dependent variable. With a Two Way ANOVA, there are two independents. Use a two way ANOVA when you have one measurement variable (i.e. a quantitative variable) and two nominal variables. In other words, if your experiment has a quantitative outcome and you have two categorical explanatory variables, a two way ANOVA is appropriate.

For example, you might want to find out if there is an interaction between income and gender for anxiety level at job interviews. The anxiety level is the outcome, or the variable that can be measured.

Gender and Income are the two categorical variables. These categorical variables are also the independent variables, which are called **factors** in a Two Way ANOVA.

The factors can be split into levels. In the above example, income level could be split into three levels: low, middle and high income. Gender could be split into three levels: male, female, and transgender. Treatment groups are all possible combinations of the factors. In this example there would be 3 x 3 = 9 treatment groups.

**Main Effect and Interaction Effect**

The results from a Two Way ANOVA will calculate a main effect and an interaction effect. The main effect is similar to a One Way ANOVA: each factor's effect is considered separately.

With the interaction effect, all factors are considered at the same time. Interaction effects between factors are easier to test if there is more than one observation in each cell. For the above example, multiple stress scores could be entered into cells. If you do enter multiple observations into cells, the number in each cell must be equal.

Two null hypotheses are tested if you are placing one observation in each cell. For this example, those hypotheses would be: H01: All the income groups have equal mean stress. H02:

All the gender groups have equal mean stress. For multiple observations in cells, you would also be testing a third hypothesis: H03:

The factors are independent or the interaction effect does not exist. An F-statistic is computed for each hypothesis you are testing.

**Assumptions for Two Way ANOVA**

- The population must be close to a normal distribution.
- Samples must be independent.
- Population variances must be equal.
- Groups must have equal sample sizes.

**MANOVA**

MANOVA is just an ANOVA with several dependent variables. It's similar to many other tests and experiments in that it's purpose is to find out if the response variable (i.e. your dependent variable) is changed by manipulating the independent variable. The test helps to answer many research questions, including:

- Do changes to the independent variables have statistically significant effects on dependent variables?
- What are the interactions among dependent variables?
- What are the interactions among independent variables?

**MANOVA Example**

Suppose you wanted to find out if a difference in textbooks affected students' scores in math and science. Improvements in math and science means that there are two dependent variables, so a MANOVA is appropriate. An ANOVA will give you a single (univariate) f-value while a MANOVA will give you a multivariate F value. MANOVA tests the multiple dependent variables by creating new, artificial, dependent variables that maximize group differences. These new dependent variables are linear combinations of the measured dependent variables.

**Interpreting the MANOVA**

results If the multivariate F value indicates the test is statistically significant, this means that something is significant. In the above example, you would not know if math scores have improved, science scores have improved (or both). Once you have a significant result, you would then have to look at each individual component (the univariate F tests) to see which dependent variable(s) contributed to the statistically significant result. Advantages

1. MANOVA enables you to test multiple dependent variables.

2. MANOVA can protect against Type I errors. Disadvantages

1. MANOVA is many times more complicated than ANOVA, making it a challenge to see which independent variables are affecting dependent variables.

2. One degree of freedom is lost with the addition of each new variable.

3. The dependent variables should be uncorrelated as much as possible. If they are correlated, the loss in degrees of freedom means that there isn't much advantages in including more than one dependent variable on the test.

**Factorial ANOVA**

A factorial ANOVA is an Analysis of Variance test with more than one independent variable, or "factor". It can also refer to more than one Level of Independent Variable. For example, an experiment with a treatment group and a control group has one factor (the treatment) but two levels (the treatment and the control).

The terms "two-way" and "three-way" refer to the number of factors or the number of levels in your test. Four-way ANOVA and above

are rarely used because the results of the test are complex and difficult to interpret.

- A two-way ANOVA has two factors (independent variables) and one dependent variable. For example, time spent studying and prior knowledge are factors that affect how well you do on a test.

- A three-way ANOVA has three factors (independent variables) and one dependent variable. For example, time spent studying,

prior knowledge, and hours of sleep are factors that affect how well you do on a test Factorial ANOVA is an efficient way of conducting a test.

Instead of performing a series of experiments where you test one independent variable against one dependent variable, you can test all independent variables at the same time.

Variability In a one-way ANOVA, variability is due to the differences between groups and the differences within groups. In factorial ANOVA, each level and factor are paired up with each other ("crossed").

This helps you to see what interactions are going on between the levels and factors. If there is an interaction then the differences in one factor depend on the differences in another.

Let's say you were running a two-way ANOVA to test male/female performance on a final exam. The subjects had either had 4, 6, or 8 hours of sleep.

- IV1: SEX (Male/Female)

- IV2: SLEEP (4/6/8) • DV: Final Exam Score A two-way factorial ANOVA would help you answer the following questions:

1. Is sex a main effect? In other words, do men and women differ significantly on their exam performance?

2. Is sleep a main effect? In other words, do people who have had 4,6, or 8 hours of sleep differ significantly in their performance?
3. Is there a significant interaction between factors? In other words, how do hours of sleep and sex interact with regards to exam performance?

4. Can any differences in sex and exam performance be found in the different levels of sleep? Assumptions of Factorial ANOVA

- Normality: the dependent variable is normally distributed.

- Independence: Observations and groups are independent from each other.

- Equality of Variance: the population variances are equal across factors/levels.

## Complete and incomplete block designs:

In most of the experiments, the available experimental units are grouped into blocks having more or less identical characteristics to remove the blocking effect from the experimental error. Such design is termed as block designs. The number of experimental units in a block is called the block size. If size of block = number of treatments and each treatment in each block is randomly allocated, then it is a full replication and the design is called a complete block design. In case, the number of treatments is so large that a full replication in each block makes

it too heterogeneous with respect to the characteristic under study, then smaller but homogeneous blocks can be used. In such a case, the blocks do not contain a full replicate of the treatments. Experimental designs with blocks containing an incomplete replication of the treatments are called incomplete block designs.

**Completely randomized design (CRD)**

The CRD is the simplest design. Suppose there are v treatments to be compared. All experimental units are considered the same and no division or grouping among them exist.•

In CRD, the v treatments are allocated randomly to the whole set of experimental units, without

• making any effort to group the experimental units in any way for more homogeneity. Design is entirely flexible in the sense that any number of treatments or replications may be used

.• The number of replications for different treatments need not be equal and may vary from treatment to

• treatment depending on the knowledge (if any) on the variability of the observations on individual treatments as well as on the accuracy required for the estimate of individual treatment effect.

**Example:**

Suppose there are 4 treatments and 20 experimental units,

then –

the treatment 1 is replicated, say 3 times and is given to 3 experimental units, -

the treatment 2 is replicated, say 5 times and is given to 5 experimental units, - the treatment 3 is replicated, say 6 times and is given to 6 experimental unitsand –

finally, the treatment 4 is replicated [20-(6+5+3)=]6 times and is given to the remaining 6 experimental units.

**Randomized Block Design**

If a large number of treatments are to be compared, then a large number of experimental units are required. This will increase the variation among the responses and CRD may not be appropriate to use. In such a case when the experimental material is not homogeneous and there are v treatments to be compared, then it may be possible to group the experimental material into blocks of sizes v units.

- Blocks are constructed such that the experimental units within a block are relatively homogeneous

- and resemble to each other more closely than the units in the different blocks. If there are b such blocks, we say that the blocks are at b levels. Similarly, if there are v treatments,

- we say that the treatments are at v levels. The responses from the b levels of blocks and v levels of treatments can be arranged in a two-way layout. The observed data set is arranged as follows:

**Layout:**

A two-way layout is called a randomized block design (RBD) or a randomized complete block design (RCB) if, within each block, the v treatments are randomly assigned to v experimental units such that each of the v! ways of assigning the treatments to the units has the

same probability of being adopted in the experiment and the assignment in different blocks are statistically independent.

**Randomization:**

- Number the v treatments 1,2,…,v. - Number the units in each block as 1, 2,...,v. - Randomly allocate the v treatments to v experimental units in each block.

**Replication**

Since each treatment is appearing in each block, so every treatment will appear in all the blocks. So each treatment can be considered as if replicated the number of times as the number of blocks. Thus in RBD, the number of blocks and the number of replications are same.

**Local control Local control is adopted in RBD in the following way: -**

First form the homogeneous blocks of the experimental units. - Then allocate each treatment randomly in each block. The error variance now will be smaller because of homogeneous blocks and some variance will be parted away from the error variance due to the difference among the blocks. Example: Suppose there are 7 treatments denoted as 12 7 TT T , ,.., corresponding to 7 levels of a factor to be included in 4 blocks.

## Latin Square Design

The treatments in the RBD are randomly assigned to b blocks such that each treatment must occur in each block rather than assigning them at random over the entire set of experimental units as in the CRD.

There are only two factors – block and treatment effects – which are taken into account and the total number of experimental units needed for complete replication are bv where b and v are the numbers of blocks and treatments respectively.

If there are three factors and suppose there are b, v and k levels of each factor, then the total number of experimental units needed for a complete replication are bvk.

This increases the cost of experimentation and the required number of experimental units over RBD. In Latin square design (LSD), the experimental material is divided into rows and columns, each having the same number of experimental units which is equal to the number of treatments.

The treatments are allocated to the rows and the columns such that each treatment occurs once and only once in each row and in each column. In order to allocate the treatment to the experimental units in rows and columns, we take help from

**Latin squares**

Latin Square: A Latin square of order p is an arrangement of p symbols in 2 p cells arranged in p rows and p columns such that each symbol occurs once and only once in each row and in each column. For example, to write a Latin square of order 4, choose four symbols – A, B, C and D.

These letters are Latin letters which are used as symbols. Write them in a way such that each of the letters out of A, B, C and D occurs once and only once in each row and each column. For example, asThis is a Latin square. We consider first the following example to illustrate how a Latin square is used to allocate the treatments and in getting the response.

**Example:**

Suppose different brands of petrol are to be compared with respect to the mileage per litre achieved in motor cars. Important factors responsible for the variation in mileage are - the difference between individual

cars. - the difference in the driving habits of drivers. We have three factors – cars,

drivers and petrol brands. Suppose we have –

4 types of cars denoted as

1, 2, 3, 4. - 4 drivers that are represented by

a, b, c, d. – 4

brands of petrol are indicated as

A, B, C, D. the number of experiments. We choose only

Now the complete replication will require 4 4 4 64 experiments. To choose such 16 experiments, we take the help of the Latin square. Suppose we choose the following Latin square:

Write them in rows and columns and choose rows for drivers, columns for cars and letter for petrol brands. Thus 16 observations are recorded as per this plan of treatment combination (as shown in the next figure) and further analysis is carried out. Since such design is based on Latin square, so it is called as a Latin square design.

The LSD is an incomplete three-way layout in which each of the three factors, viz, rows, columns and treatments, is at v levels each and observations only on 2 v of the 3 v possible treatment

combinations are taken. Each treatment combination contains one level of each factor. The analysis of data in an LSD is conditional in the sense it depends on which Latin square is used for allocating the treatments. If the Latin square changes, the conclusions may also change.

**Standard form of Latin square**

A Latin square is in the standard form if the symbols in the first row and first columns are in the natural order (Natural order means the order of alphabets like A, B, C, D,…). Given a Latin square, it is possible to rearrange the columns so that the first row and first column remain in a natural order.

Orthogonal Latin squares If two Latin squares of the same order but with different symbols are such that when they are superimposed on each other, every ordered pair of symbols (different) occurs exactly once in the Latin square, then they are called orthogonal.

Mutually orthogonal Latin square A set of Latin squares of the same order is called a set of mutually orthogonal Latin square (or a hyper Graeco-Latin square) if every pair in the set is orthogonal. The total number of mutually orthogonal Latin squares of order p is at most (p - 1).

Analysis of LSD (one observation per cell) In designing an LSD of order p, choose one Latin square at random from the set of all possible Latin squares of order p

.• Select a standard Latin square from the set of all standard Latin squares with equal probability.

- Randomize all the rows and columns as follows:

- - Choose a random number, less than p, say 1 n and then 2nd row is the 1 n th row. - Choose another random number less than p, say 2 n and then 3rd row is the 2 th n row and so on. - Then do the same for the column. For Latin squares of the order less than 5, fix the first row and then randomize rows and then

- randomize columns. In Latin squares of order 5 or more, need not to fix even the first row. Just randomize all rows and columns.

## Measures design psychology

An independent measures design is a research method in which multiple experimental groups are used and participants are only in one group. Each participant is only in one condition of the independent variable during the experiment.

An example would be a drug trial for a new pharmaceutical. To test the effect on the disorder and discover any side effects an independent measures design could be used. The researchers use two different conditions: group A who receives the drug and group B who receives a placebo (a fake pill). The participants would be randomly assigned to one of the two groups- for it to be an independent measures design each participant would either be in group A or B, not both. Advantages of independent measures design include less time/money involved than a within subjects design and increased external validity because more participants are used. A disadvantage is that individual differences in participants can sometimes lead to differences in the groups' results. This can lead to false conclusions that the different conditions caused results when it was really just individual

differences between the participants. Random sampling can help with this problem.

This should be done by random allocation, which ensures that each participant has an equal chance of being assigned to one group or the other.

Independent measures involve using two separate groups of participants; one in each condition. For example:

- **Con**: More people are needed than with the repeated measures design (i.e., more time consuming).
- **Pro**: Avoids order effects (such as practice or fatigue) as people participate in one condition only. If a person is involved in several conditions, they may become bored, tired and fed up by the time they come to the second condition, or becoming wise to the requirements of the experiment!
- **Con**: Differences between participants in the groups may affect results, for example; variations in age, gender or social background. These differences are known as participant variables (i.e., a type of extraneous variable).
- **Control**: After the participants have been recruited, they should be randomly assigned to their groups. This should ensure the groups are similar, on average (reducing participant variables).

**Repeated Measures:**

Repeated Measures design is an experimental design where the same participants take part in each condition of the independent variable. This means that each condition of the experiment includes the same group of participants.

Repeated Measures design is also known as within groups, or within-subjects design.

- **Pro**: As the same participants are used in each condition, participant variables (i.e., individual differences) are reduced.
- **Con**: There may be order effects. Order effects refer to the order of the conditions having an effect on the participants' behavior. Performance in the second condition may be better because the participants know what to do (i.e. practice effect). Or their performance might be worse in the second condition because they are tired (i.e., fatigue effect). This limitation can be controlled using counterbalancing.
- **Pro**: Fewer people are needed as they take part in all conditions (i.e. saves time).
- **Control**: To combat order effects the researcher counter balances the order of the conditions for the participants. Alternating the order in which participants perform in different conditions of an experiment. Counterbalancing
- Suppose we used a repeated measures design in which all of the participants first learned words in 'loud noise' and then learned it in 'no noise.' We would expect the participants to show better learning in 'no noise' simply because of order effects, such as practice. However, a researcher can control for order effects using counterbalancing.
- The sample would split into two groups experimental (A) and control (B). For example, group 1 does 'A' then 'B,' group 2 does 'B' then 'A' this is to eliminate order effects. Although order effects occur for each participant, because they occur

equally in both groups, they balance each other out in the results.

## Cohort studies

Cohort design is a type of nonexperimental or observational study design. In a cohort study, the participants do not have the outcome of interest to begin with. They are selected based on the exposure status of the individual. They are then followed over time to evaluate for the occurrence of the outcome of interest. Some examples of cohort studies are

(1) Framingham Cohort study,

(2) Swiss HIV Cohort study, and

(3) The Danish Cohort study of psoriasis and depression.

These studies may be prospective, retrospective, or a combination of both of these types. Since at the time of entry into the cohort study, the individuals do not have outcome, the temporality between exposure and outcome is well defined in a cohort design. If the exposure is rare, then a cohort design is an efficient method to study the relation between exposure and outcomes. A retrospective cohort study can be completed fast and is relatively inexpensive compared with a prospective cohort study. Follow-up of the study participants is very important in a cohort study, and losses are an important source of bias in these types of studies. These studies are used to estimate the cumulative incidence and incidence rate. One of the main strengths of a cohort study is the longitudinal nature of the data. Some of the variables in the data will be time-varying and some may be time independent. Thus, advanced modeling

techniques (such as fixed and random effects models) are useful in analysis of these studies.

Cohort studies are important in research design. The term “cohort” is derived from the Latin word “Cohors” – “a group of soldiers.” It is a type of nonexperimental or observational study design. The term “cohort” refers to a group of people who have been included in a study by an event that is based on the definition decided by the researcher. For example, a cohort of people born in Mumbai in the year 1980. This will be called a “birth cohort.” Another example of the cohort will be people who smoke. Some other terms which may be used for these studies are “prospective studies” or “longitudinal studies.”

In a cohort study, the participants do not have the outcome of interest to begin with. They are selected based on the exposure status of the individual. Thus, some of the participants may have the exposure and others do not have the exposure at the time of initiation of the study. They are then followed over time to evaluate for the occurrence of the outcome of interest.

As seen in  at baseline, some of the study participants have exposure (defined as exposed) and others do not have the exposure (defined as unexposed). Over the period of follow-up, some of the exposed individuals will develop the outcome and some unexposed individuals will develop the outcome of interest. We will compare the outcomes in these two groups.

**Framingham cohort study**

This cohort study was initiated in 1948 in Framingham. Framingham, at the time of initiation of the cohort, was an industrial town 21 miles west of Boston with a population of 28,000. This

Framingham Heart Study recruited 5209 men and women (30–62-year-old) in the study to assess the factors associated with cardiovascular disease (CVD). The researchers also recruited second generation participants (children of original participants) in 1971 and the third general participants in 2002. This has been one of the landmark cohort studies and has contributed immensely to our knowledge of some of the important risk factors for CVD. The investigators have published 3064 publications using the Framingham Heart Study data.

**Swiss HIV cohort study**

This cohort study was initiated in 1988. It was a longitudinal study of HIV-infected individuals to conduct research on HIV pathogenesis, treatment, immunology, and coinfections. They also work on the social aspects of the disease and management of HIV-infected pregnant women. The study started with a recruitment of individuals ≥16 years. The cohort was gradually expanded to include the Swiss Mother and Child HIV Cohort Study. The cohort has provided useful information on various aspects of HIV and published 542 manuscripts on these aspects.

**The Danish cohort study of psoriasis and depression (Jensen, 2015)**

This is another large cohort study that evaluated the association between psoriasis and onset of depression. The participants in the cohort were enrolled from national registries in Denmark. None of the included participants had psoriasis or depression at baseline. The outcome of interest was the initiation of antidepressants or hospitalization for depression. The authors compared the incidence rates of hospitalization for depression in psoriasis and reference population. The psoriasis group was further classified as mild and

moderate psoriasis. The authors found that psoriasis was an independent risk factor for new-onset depression in young people. However, in the elderly, it was mediated through comorbid conditions.

We have presented examples of some large cohort studies. It will be worthwhile to read the design and conduct of these studies, and it will help the readers understand the practical aspects of conducting and analyzing cohort studies.

## Types of Cohort Studies

### Prospective cohort study

In this type of cohort study, all the data are collected prospectively. The investigator defines the population that will be included in the cohort. They then measure the potential exposure of interest. The participants are then classified as exposed or unexposed by the investigator. The investigator then follows these participants. At baseline and during follow-up, the investigator also collects information on other variables that are important for the study (such as confounding variables). The investigator then assesses the outcome of interest in these individuals. Some of these outcomes may only occur once (for example, death), and some may occur multiple times (for example, conditions which may recur in the same individual – diarrhea, wheezing episodes, etc.).

### Retrospective cohort study

In this type of cohort study, the data are collected from records. Thus, the outcomes have occurred in the past. Even though the outcomes have occurred in the past, the basic study design is essentially the same. Thus, the investigator starts with the exposure

and other variables at baseline and at follow-up and then measures the outcome during the follow-up period.

Sometimes, the direction may not be as well defined as prospective and retrospective. One may analyze retrospective data on a group of people well as collect prospective data from the same individuals.

**Examples of prospective and retrospective cohort studies**

**Example 1**

Our objective is to estimate the incidence of cardiovascular events in patients with psoriasis. We have decided to conduct a 10-year study. All the individuals who are diagnosed with psoriasis are eligible for being included in this cohort study. However, one has to ensure that none of them have cardiovascular events at baseline. Thus, they should be thoroughly investigated for the presence of these events at baseline before including them in the study. For this, we have to define all the events we are interested in the study (such as angina or myocardial infarction). The criteria for identifying psoriasis and cardiovascular outcomes should be decided before initiating the study. All those who do not have cardiovascular outcomes should be followed at regular intervals (predecided by the researcher and as required for clinical management). This will be a prospective cohort study.

**Example 2**

Our objective is to assess the survival in HIV-infected individuals and the factors associated with survival. We have clinical data from about 430 HIV-infected individuals in the center. The follow-up period ranges from 3 months to 4 years, and we know that 33 individuals have died in this group. We decide to perform the survival analysis in this group of individuals. We prepare a clinical

record form and abstract data from these clinical forms. This design will be a retrospective cohort study.

## Outcomes in a Cohort Study

A cohort study may have different types of outcomes. Some of the outcomes may occur only once. In the above mentioned retrospective study, if we assess the mortality in these individuals, then the outcome will occur only once. Other outcomes in the cohort study may be measured more than once. For instance, if we assess CD4 counts in the same retrospective study, then the values of CD4 counts may change at every visit. Thus, the outcome will be measured at every visit.

## Strengths of a Cohort Study

- Temporality: Since at the time of entry into the cohort study, the individuals do not have outcome, the temporality between exposure and outcome is well defined
- A cohort study helps us to study multiple outcomes in the same exposure. For example, if we follow patients of hypercholesterolemia, we can study the incidence of melasma or psoriasis in them. Thus, there is one exposure (hypercholesterolemia) and multiple outcomes (melasma and psoriasis). However, we have to ensure that none of the individuals have any of the outcomes at the baseline
- If the exposure is rare, then a cohort design is an efficient method to study the relation between exposure and outcomes
- It is generally said that a cohort design may not be efficient for rare outcomes (a case-control design is preferred). However, if the rare outcome is common in some exposures, then it may

be useful to follow a cohort design. For example, melanoma is not a common condition in India. Hence, if we follow individuals to study the incidence of melanoma, then it may not be efficient. However, if we know that, theoretically, a particular chemical may be associated with melanoma, then we should follow a cohort of individuals exposed to this chemical (in occupational settings or otherwise) and study the incidence of melanoma in this group

- In a prospective cohort study, the exposure variable, other variables, and outcomes may be measured more accurately. This is important to maintain uniformity in the measurement of exposures and outcomes. This is also useful for exposures that may require subjective assessment or recall by the patient. For example, dietary history, smoking history, or alcoholic history, etc. This may help in reducing the bias in measurement of exposure
- A retrospective cohort study can be completed fast and is relatively inexpensive compared with a prospective cohort study. However, it also has other strengths of the prospective cohort study.

**Limitations of a Cohort Study**

- One major limitation of a prospective cohort design is that is time consuming and costly. For example, if we have to study the incidence of cardiovascular patients in patients of psoriasis, we may have to follow them up for many years before the outcome occurs
- In a retrospective cohort study, the exposure and the outcome variables are collected before the study has been initiated.

Thus, the measurements may not be very accurate or according to our requirements. In addition, the some of the exposures may have been assessed differently for various members of the cohort

- As discussed earlier, cohort studies may not be very efficient for rare outcomes except in some conditions.

**Additional Points in Cohort Studies**

Multiple cohort study

Sometimes, we may be interested to compare the outcomes in two or more groups of individuals. Thus, we may have a multiple cohort study. It is important the exposure, outcome, and other variables should be measured similarly in both the study and the comparison group.

Measurement of exposure and outcome

Since the individuals are included in the study based on the exposure status, this has to be well defined and accurate. The outcomes also have to be well defined and measured similarly in all the participants. If you have more than one group in the cohort (as in multiple cohorts or reference population), you should ensure that the follow-up protocols are similar in all the groups.

It is quite possible that individuals participating in a cohort study may not be correctly classified – some exposed individuals may be classified as unexposed and the other way round. If the misclassification of the exposure or the outcome is random or nondifferential, then the two groups will be similar and the estimates from the study will be biased towards the null. Thus, we will underestimate the association between the exposure and the

outcome. If, however, the misclassification is differential or nonrandom, then the estimates may be biased toward the null, away from the null, or may be an appropriate estimate.

**Follow-up**

Follow-up of the study participants is very important in a cohort study and losses are an important source of bias in these types of studies. Some patients are lost to follow-up in large cohorts; however, if the proportion is very high (>30%), then the validity of the results from this study are doubtful. This loss to follow-up becomes all the more important if it is related to the exposure or outcome of interest. For example, in our prospective study, majority of the patients who were lost to follow-up had severe psoriasis at the baseline, then we will get biased estimates from the study. Thus, managing follow-ups and minimizing losses are an important component of the design of a cohort study.

**Nested case-control study**

This is a specific type of study design nested within a cohort study. In this, the investigator will match the controls to the cases within a specific cohort.

The exposure of interest will be assessed in these selected cases and controls. For example, our hypothesis is that there is a biological marker that in present/elevated (to begin with) in individuals who develop cardiovascular events in psoriatic patients.

It is expensive to assess this marker in all patients. Thus, we select all those who develop the outcomes (cases) in our cohort and a sample of individuals who do not develop the outcomes (controls). An important aspect, however, is that we should have stored the biological material that we have collected at baseline, and the

biological marker should be assessed in this sample. This procedure maintains the temporal strength of the cohort study.

## Time Series

The purpose of the present paper is to present a methodological approach to such research areas as psychotherapy, education, psychophysiology, operant research, etc., where the data consist of dependent observations over time. Existing methodologies are frequently inappropriate to research in these areas; common field methodologies are unable to control irrelevant variables and eliminate rival hypotheses, while traditional parametric laboratory designs relying on control groups are often unsuitable. New data-analysis techniques have made possible the development of a different methodological approach which can be applied in either the laboratory or in natural (field) settings. This approach is responsive to ecological considerations (Willems, 1965) while permitting satisfactory experimental control. Control is achieved by a network of complementary control strategies, not solely by control-group designs.

## INTERRUPTED TIME SERIES DESIGN

A variant of the pretest-posttest design is the **interrupted time-series design**. A time series is a set of measurements taken at intervals over a period of time. For example, a manufacturing company might measure its workers' productivity each week for a year. In an interrupted time series-design, a time series like this one is "interrupted" by a treatment.

In one classic example, the treatment was the reduction of the work shifts in a factory from 10 hours to 8 hours (Cook & Campbell,

1979). Because productivity increased rather quickly after the shortening of the work shifts, and because it remained elevated for many months afterward, the researcher concluded that the shortening of the shifts caused the increase in productivity.

Notice that the interrupted time-series design is like a pretest-posttest design in that it includes measurements of the dependent variable both before and after the treatment. It is unlike the pretest-posttest design, however, in that it includes multiple pretest and posttest measurements.

Figure 8.1 shows data from a hypothetical interrupted time-series study. The dependent variable is the number of student absences per week in a research methods course. The treatment is that the instructor begins publicly taking attendance each day so that students know that the instructor is aware of who is present and who is absent.

The top panel of Figure shows how the data might look if this treatment worked. There is a consistently high number of absences before the treatment, and there is an immediate and sustained drop in absences after the treatment.

The bottom panel of Figure shows how the data might look if this treatment did not work. On average, the number of absences after the treatment is about the same as the number before. This figure also illustrates an advantage of the interrupted time-series design over a simpler pretest-posttest design.

If there had been only one measurement of absences before the treatment at Week 7 and one afterward at Week 8, then it would have looked as though the treatment were responsible for the reduction. The multiple measurements both before and after the

treatment suggest that the reduction between Weeks 7 and 8 is nothing more than normal week-to-week variation.

## THE USE OF TIME SERIES IN DESIGN

The most persuasive experimental evidence comes from a triangulation of research designs as well as from a triangulation of measurement processes. The following three designs, when used in conjunction, represent such a triangulation:

(a) the one-group pretest-posttest design;

(b) the time-series design; and

(c) the multiple time-series design. These designs need not be applied simultaneously;

### The One-Group Pretesl-FosUest Design

This design, although inadequate when used alone, makes a significant and unique contribution to the total design package. It provides an external criterion measure of the outcome of a programmed intervention. Each subject serves as his own control, and the difference between his pre- and posttest scores represents a stringent measure of the degree to which "real life" program goals have been achieved.2

For example, the ultimate success of psychotherapy is best evaluated in terms of extratherapeutic behavior change. This design, then, documents the fact of outcome-change without pinpointing the process producing the change.

### The Time-Series Design This design

involves successive observations throughout a programmed intervention and assesses the characteristics of the change

process. It is truly the mainstay of the proposed design package because it serves several simultaneous functions. First, it is descriptive.

The descriptive function of the time series is particularly important when the intervention extends over a considerable time period. The time series is the only design to furnish a continuous record of fluctuations in the experimental variables over the entire course of the program.

Second, the time-series design functions as an heuristic device. When coupled with a carefully kept historical log of potentially relevant nonexperimental events, the time series is an invaluable source of post hoc hypotheses regarding observed, but unplanned, changes in program variables.

Moreover, where treatment programs require practical administrative decisions, the time series serves as a source of hypotheses regarding the most promising decisions, and later as a feedback source regarding the consequences and effectiveness of such decisions.

Finally, the time series can function as a quasi-experimental design for planned interventions imbedded in the total program when a control group is implausible.

depicts a time-series experiment with an extended intervention ; of course, in some cases, the intervention might simply be a discrete event. A time-series analysis must demonstrate that the perturbations of a system are not uncontrolled variations, that is, noise in the system. It is precisely this problem of partitioning noise from "effect" that has discouraged the use of time series in the social sciences

## The Multiple Time-Series Design

This design is basically a refinement of the simple time series. It is yet a more precise method for investigating specific program hypotheses because it allows the time series of the experimental group to be compared with that of a control group. As a result, it offers a greater measure of control over unwanted sources of rival hypotheses.

## THE ANALYSIS OF TIME-SERIES DATA

The data resulting from the best of experimental designs is of little value unless subsequent statistical analyses permit the investigator to test the extent to which obtained differences exceed chance fluctuations. The above design package, with its emphasis on time-series designs, is a realistic possibility only because of recent developments in the field of mathematics. Appropriate analysis techniques have evolved from work in such diverse areas as economics, meteorology,

industrial quality control, and psychology. Historically, the time-series design has been neglected due to the lack of such appropriate analytical techniques. Two statistical methods for solving the problem of time-series analyses are presented below.

## MANOVA

Multivariate ANOVA (MANOVA) extends the capabilities of analysis of variance (ANOVA) by assessing multiple dependent variables simultaneously. ANOVA statistically tests the differences between three or more group means. For example, if you have three different teaching methods and you want to evaluate the average scores for these groups, you can use ANOVA. However, ANOVA does have a drawback. It can assess only

one dependent variable at a time. This limitation can be an enormous problem in certain circumstances because it can prevent you from detecting effects that actually exist.

MANOVA provides a solution for some studies. This statistical procedure tests multiple dependent variables at the same time. By doing so, MANOVA can offer several advantages over ANOVA.

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**MANOVA Assesses the Data**

Let's see what patterns we can find between the dependent variables and how they are related to teaching method. I'll graph the test and satisfaction scores on the scatterplot and use teaching method as the grouping variable. This multivariate approach represents how MANOVA tests the data. These are the same data, but sometimes how you look at them makes all the difference.

The graph displays a positive correlation between Test scores and Satisfaction. As student satisfaction increases, test scores tend to

increase as well. Moreover, for any given satisfaction score, teaching method 3 tends to have higher test scores than methods 1 and 2. In other words, students who are equally satisfied with the course tend to have higher scores with method 3. MANOVA can test this pattern statistically to help ensure that it's not present by chance.

In your preferred statistical software, fit the MANOVA model so that Method is the independent variable and Satisfaction and Test are the dependent variables.

MANOVA Provides Benefits

Use multivariate ANOVA when your dependent variables are correlated. The correlation structure between the dependent variables provides additional information to the model which gives MANOVA the following enhanced capabilities:

- **Greater statistical power**: When the dependent variables are correlated, MANOVA can identify effects that are smaller than those that regular ANOVA can find.
- **Assess patterns between multiple dependent variables**: The factors in the model can affect the relationship between dependent variables instead of influencing a single dependent variable. As the example in this post shows, ANOVA tests with a single dependent variable can fail completely to detect these patterns.
- **Limits the joint error rate**: When you perform a series of ANOVA tests because you have multiple dependent variables, the joint probability of rejecting a true null hypothesis increases with each additional test. Instead, if you perform one MANOVA test, the error rate equals the significance level.

(1) reading, (2) mathematics, and (3) moral reasoning skills. Using MANOVA the psychologist could examine how the two groups differ on a linear combination of the three measures. Perhaps the Catholic school children score higher on moral reasoning skills relative to reading and math when compared to the public school children? Perhaps the Catholic school children score higher on both moral reasoning skills and math relative to reading when compared to the public school children? These potential outcomes, or questions, are multivariate in nature because they treat the quantitative measures simultaneously and recognize their potential inter-relatedness. The goal of conducting a MANOVA is thus to determine how quantitative variables can be combined to maximally discriminate between distinct groups of people, places, or things.

As will be discussed below this goal also includes determining the theoretical or practical meaning of the derived linear combination or combinations of variables.

## CONDUCTING THE MANOVA

Returning to the Big Five trait example, let us decide to pursue a truly multivariate approach. In other words, let us commit to examining the linear combinations of personality traits that might differentiate between the European American (EA), Asian American (AA), and Asian International (AI) students. Assuming that no a priori model for combining the Big Five traits is available, these six steps will consequently be followed:

## APPLIED MULTIVARIATE RESEARCH

1. Conduct an omnibus test of differences among the three groups on linear combinations of the five personality traits.

2. Examine the linear combinations of personality traits embodied in the discriminant functions.

3. Simplify and interpret the strongest linear combination.

4. Test the simplified linear combination (multivariate composite) for statistical significance.

5. Conduct follow-up tests of group differences on the simplified multivariate composite.

6. Summarize results in APA style If an existing model for combining the traits were available, a priori, then an abbreviated approach, which will be discussed near the end of this paper, would be undertaken.

Step 1: Conducting the Omnibus MANOVA. The omnibus null hypothesis for this example posits the EA, AA, and AI groups are equal with regard to their population means on any and all linear combinations of the Big Five personality traits.

This hypothesis can be tested using any one of the major computer software packages. In SPSS for Windows the General Linear Model (GLM) procedure can be used or the dated MANOVA routine can be run through the syntax editor.

**Single-Factor ANCOVA**

In this model a single-factor ANOVA model is extended by specifying one or more additional continuous (quantitative) variables called covariates. The resulting single-factor analysis of covariance (ANCOVA) model explains variation in a dependent variable by combining a categorical (qualitative) independent variable with one or more continuous (quantitative) variables. If a covariate is linearly related to the dependent variable, it will reduce pre-existing

variability between subjects. In effect, the variance component in the dependent variable which is due to covariation with the covariate is removed ("partialed out") from the dependent variable. This reduces the variance of the error term in the model, which increases the sensitivity of the ANCOVA as compared to the same model without the covariate (ANOVA model). A higher test sensitivity means that smaller mean differences between groups will become significant as compared to a standard ANOVA model.

Note that ANCOVA has a similar goal as repeated measures ANOVA, namely to remove pre-existing differences between subjects. In repeated measures ANOVA models, this is achieved by measuring the same subjects under various conditions (within-subjects) instead of assigning different subjects to different conditions. From the obtained data, changes of the dependent variable across conditions are only analyzed within each subject completely removing between-subjects variability. In ANCOVA models, the reduction of inter-subject variability depends on the strength of correlation of the covariate with the dependent variable. This consideration implies that ANCOVA models are only useful for designs with between-subjects factors but provide no benefits in pure within-subjects factorial designs.

The obvious difference between ANOVA and ANCOVA is the the letter "C", which stands for 'covariance'. Like ANOVA, "Analysis of Covariance" (ANCOVA) has a single continuous response variable. Unlike ANOVA, ANCOVA compares a response variable by both a factor and a continuous independent variable (e.g. comparing test score by both 'level of education' and 'number of hours spent studying'). The term for the continuous independent variable (IV) used in ANCOVA is "covariate".

ANCOVA is also commonly used to describe analyses with a single response variable, continuous IVs, and no factors. Such an analysis is also known as a regression. In fact, you can get almost identical results in SPSS by conducting this analysis using either the "Analyze > Regression > Linear" dialog menus or the "Analze > General Linear Model (GLM) > Univariate" dialog menus.

A key (but not only) difference in these methods is that you get slightly different output tables. Also, regression requires that user dummy code factors, while GLM handles dummy coding through the "contrasts" option. The linear regression command in SPSS also allows for variable entry in hierarchical blocks (i.e. stages).

## Single subject design psychology

Single subject research design is a type of research methodology characterized by repeated assessment of a particular phenomenon (often a behavior) over time and is generally used to evaluate interventions. Repeated measurement across time differentiates single subject research design from case studies and group designs, as it facilitates the examination of client change in response to an intervention. Although the use of single subject research design has generally been limited to research, it is also appropriate and useful in applied practice.

A wide variety of valid, useful designs exist for the measurement of a single case. These designs are either classified as qualitative or quasi experimental designs as they do not contain the provisions of random, representative samples or randomization to treatment/intervention. This classification convention also occurs

because traditional statistical analyses based classical theorems are not used.

With focus currently on evidenced-based practice/medicine in health care, more exacting measurements of treatment are needed. The purposeful, visible emphasis on process and outcome date provides the participant/client with an ongoing view of the validity of the intervention approach. The evidence-based practice movement can be addressed easily with the low cost (i.e., low expense and time expenditure).

The Scientist Practitioner Model guides clinicians to use data collected in laboratory to guide decisions of treatment implementation. In turn, treatment implementation, according to the Scientist Practitioner Model, influences the direction of research. Research evidence of treatment effectiveness is valued. In single case designs, the systematic monitoring and evaluation positions the participant/client to adopt a problem-solving experiment, conjointly with the practitioner/field researcher on herself/himself. In so doing, the findings are immediate and directly applicable to their situation In some cases, these approaches promote the generation of alternative interpretations of collected data and quite possibly, causal explanations of behaviors. The clinical practices of establishing support, setting up a conceptual/ethical concept of clients' situation, identification of areas of change/strength/weakness, selection and implementation of treatment, evaluation of change/plan for relapse and follow-up are conducted within the simple case design context.

All single case designs involve training the participant/client in observation practices. This training of the individual to understand what behavior to record, how to record the behavior and when to

record the behavior is central to single case design. It is common for the practitioner/field researcher to work with the participant/client in their selection of a behavior to change and thereby,

record.This becomes important as this descriptive data will ultimately become the pivotal source of information about the functional relationship between the target behavior for change and those behaviors that precede and follow (i.e., antecedent consequences) as they are typically interdependent. In fact, this circumstance is what is termed the functional assessment. Some representative target behaviors often used in an ABA single case design are: nutrition; hydration – amount of water;

weight gain or loss; medication compliance; adherence to treatment; smoking cessation; substance use cessation. Client's values are incorporated

in the choice of targets and goal setting procedures. The baseline measurement is followed by the implementation of a change in a target behavior such as the examples listed above. After the implementation period, the participant/client returns to an adlib or no intervention schedule.

The ABA design, like other single case designs, allows the client values to be incorporated into the choice of targets and goal setting procedures.In the AB design, the intervention is followed by a baseline period.

Conclusions

We find that single case designs are powerful measurement tools of behavior. The challenges and need for quantification that occurs in field settings can be uniquely and precisely addressed with single case designs.

# Research Methodology and Statistics MCQs

DIWAKAR EDUCATION HUB

**1. Who authored the book "methods in Social Research"**
**A. Wilkinson**
**B. CR Kothari**
**C. Kerlinger**
**D. Goode and Halt**
**Ans:- D**

**2. "Research is an organized and systematic enquiry" Defined by**
**A. Marshall**
**B. P.V. Young**
**C. Emory**
**D. Kerlinger**
**Ans:- C**

**3. Research is a "Scientific undertaking" opined by**
**A. Young**
**B. Kerlinger**
**C. Kothari**
**D. Emory**
**Ans:- A**

**4. "A systematic step-by-step Procedure following logical process of reasoning" called**
**A. Experiment**
**B. Observation**
**C. Deduction**
**D. Scientific method Ans:- D**

**5. Ethical Neutrality is a feature of**
**A. Deduction**
**B. Scientific method**
**C. Observation**
**D. Experience**
**Ans:- B**

**6. Scientific method is committed to …….**
**A. Objectivity**
**B. Ethics**
**C. Proposition**
**D. Neutrality**
**Ans:- A**

**7. "One of the methods of logical reasoning process" is called**
**A. Induction**
**B. Deduction**
**C. Research**
**D. Experiment**
**Ans:- A**

**8. An essential Criterion of Scientific study is**
**A. Belief**
**B. Value**
**C. Objectivity**
**D. Subjectivity**
**Ans:- C**

**9. "Reasoning from general to particular "is called**
**A. Induction**
**B. deduction**
**C. Observation**
**D. experience**
**Ans:- B**

**10. "Deduction and induction are a part of system of reasoning" – stated by**
**A. Caroline**
**B. P.V.Young**
**C. Dewey John**
**D. Emory**
**Ans:- B**

**11. " A system of systematically interrelated concepts definitions and propositions that are advanced to explain and predict phenomena" … is**
**A. Facts**
**B. Values**
**C. Theory**
**D. Generalization**
**Ans:- C**

**12. " A system of systematically interrelated concepts, definitions and propositions that are advanced to explain and Predict phenomena" defined by**
**A. Jack Gibbs**
**B. PV Young**
**C. Black**
**D. Rose Arnold**
**Ans:- B**

**13. Theory is " a set of systematically related propositions specifying casual relationship among variables" is defined by**
**A. Black James and Champion**
**B. P.V. Young**
**C. Emory**
**D. Gibbes**
**Ans:- A**

**14. "Empirically verifiable observation" is**
**A. Theory**
**B. Value**
**C. Fact**
**D. Statement**
**Ans:- C**

**15. Fact is "empirically verifiable observation" --- is defined by**
**A. Good and Hatt**
**B. Emory**
**C. P.V. Young**
**D. Claver Ans:- A**

**16. ……. is "systematically conceptual structure of inter related elements in some**
**A. schematic form"**
**B. Concept**
**C. Variable**
**D. Model E. Facts**
**Ans:- C**

**17. Social Science deals with …….**
**A. Objects**
**B. Human beings**
**C. Living things**
**D. Non living things**
**Ans:- B**

**18. Science is broadly divided into …….**
**A. Natural and Social**
**B. Natural and Physical**
**C. Physical and Mental**
**D. Social and Physical**
**Ans:- A**

**19. Social Science try to explain ……. Between human activities and natural laws**
**A. governing them**
**B. Causal Connection**
**C. reason**
**D. Interaction**
**E. Objectives**
**Ans:- A**

**20. Social Science Research ……. Problems**
**A. Explain**
**B. diagnosis**
**C. Recommend**
**D. Formulate**
**Ans:- B**

**21. Social research aims at …….**
**A. Integration**
**B. Social Harmony**
**C. National Integration**
**D. Social Equality**
**Ans:- A**

**22. The method by which a sample is chosen**
**A. Unit**
**B. design**
**C. Random**
**D. Census**
**Ans:- B**

**23. Basing conclusions without any bias and value judgment is ……**
**A. Objectivity**
**B. Specificity**
**C. Values**

**D. Facts**
**Ans:- A**

**24. Research is classified on the basis of …….. and methods**
**A. Purpose**
**B. Intent**
**C. Methodology**
**D. Techniques**
**Ans:- B**

**25. Research undertaken for knowledge sake is**
**A. Pure Research**
**B. Action Research**
**C. Pilot study**
**D. Survey**
**Ans:- A**

**26. Example for fact finding study is**
**A. Pure Research**
**B. Survey**
**C. Action Research**
**D. Long term Research**
**Ans:- B**

**27. Facts or information's are analyzed and critical evaluation is made in**
**A. Survey**
**B. Action research**
**C. Analytical research**
**D. Pilot study Ans:- C**

**28. Research conducted to find solution for an immediate problem is ……**
**A. Fundamental Research B. Analytical Research**
**C. Survey**
**D. Action Research**
**Ans:- D**

**29. Fundamental Research is otherwise called**
**A. Action Research**
**B. Survey**
**C. Pilot study**
**D. Pure Research**
**Ans:- D**

**30. Motivation Research is a type of …… research**
**A. Quantitative**
**B. Qualitative**
**C. Pure**
**D. Applied**
**Ans:- B**

**31. Research related to abstract ideas or concepts is**
**A. Empirical research**
**B. Conceptual Research**
**C. Quantitative research**

**D. Qualitative research**
**Ans:- B**

**32. A research which follows case study method is called**
**A. Clinical or diagnostic**
**B. Causal C. Analytical**
**D. Qualitative**
**Ans:- A**

**33. Research conducted in class room atmosphere is called**
**A. Field study**
**B. Survey**
**C. Laboratory Research**
**D. Empirical Research**
**Ans:- C**

**34. Research through experiment and observation is called**
**A. Clinical Research**
**B. Experimental Research**
**C. Laboratory Research**
**D. Empirical Research**
**Ans:- D**

**35. Population Census is an example of …….. Research**
**A. Survey**
**B. Empirical**
**C. Clinical**
**D. Diagnostic**
**Ans:- A**

**36. The author of " The Grammar of Science" is**
**A. Ostle**
**B. Richard**
**C. Karl Pearson**
**D. Kerlinger**
**Ans:- C**

**37. "The Romance of Research" is authored by**
**A. Redmen and Mory**
**B. P.V.Young**
**C. Robert C meir**
**D. Harold Dazier**
**Ans:- A**

**38. …….. is a way to systematically solve the research problem**
**A. Technique**
**B. Operations**
**C. Research methodology**
**D. Research Process**
**Ans:- C**

**39. Good Research is always ……**
**A. Slow**
**B. Fast**
**C. Narrow**

**D. Systematic**
**Ans:- D**

**40. Good research is ……**
**A. Logical**
**B. Non logical**
**C. Narrow**
**D. Systematic**
**Ans:- A**

**41. "Criteria of Good Research" is written by**
**A. Delta Kappan**
**B. James Harold Fox**
**C. P.V.Young**
**D. Karl Popper**
**Ans:- B**

**42. Research method is a part of ……..**
**A. Problem**
**B. Experiment**
**C. Research Techniques**
**D. Research methodology**
**Ans:- D**

**43. Identifying causes of a problem and possible solution to a problem is**
**A. Field Study**
**B. diagnosis tic study**
**C. Action study**
**D. Pilot study**
**Ans:- B**

**44. ……. helps in social planning**
**A. Social Science Research**
**B. Experience Survey**
**C. Problem formulation**
**D. diagnostic study**
**Ans:- A**

**45. "Foundations of Behavioral Research" is written by**
**A. P.V. Young**
**B. Kerlinger**
**C. Emory**
**D. Clover Vernon**
**Ans:- B**

**46. Methods and issues in Social Research" is written by**
**A. Black James and Champions**
**B. P.V. Young**
**C. Mortan Kaplan**
**D. William Emory**
**Ans:- A**

**47. "Scientific Social Survey and Research" is written by**
**A. Best John**
**B. Emory**
**C. Clover**
**D. P.V. Young**
**Ans:- D**

**Ans:- C**

**48. "Doubt is often better than ……."**
**A. Belief**
**B. Value**
**C. Confidence**
**D. Overconfidence**
**Ans:- D**

**49. Research help in explaining the …… with which something operates.**
**A. Velocity**
**B. Momentum**
**C. Frequency**
**D. gravity**
**Ans:- C**

**50. …… is a motivation for research in students**
**A. Research degree**
**B. Research Academy**
**C. Research Labs**
**D. Research Problems**
**Ans:- A**

**51. Which of the following is an example of primary data?**
**A. Book**
**B. Journal**
**C. News Paper**
**D. Census Report**
**Ans:- C**

**52. Major drawback to researchers in India is …….**
**A. Lack of sufficient number of Universities**
**B. Lack of sufficient research guides**
**C. Lack of sufficient Fund**
**D. Lack of scientific training in research**
**Ans:- D**

**53. ICSSR stands for**
**A. Indian Council for Survey and Research**
**B. Indian Council for strategic Research**
**C. Indian Council for Social Science Research**
**D. Inter National Council for Social Science Research**
**Ans:- C**

**54. UGC Stands for**
**A. University Grants Commission**
**B. Union Government Commission**
**C. University Governance Council**
**D. Union government Council**
**Ans:- A**

**55. JRF is for**
**A. Junior Research Functions**

B. Junior Research Fellowship
C. Junior Fellowship
D. None of the above
Ans:- B

56. ……. is the first step of Research process
A. Formulation of a problem
B. Collection of Data
C. Editing and Coding
D. Selection of a problem
Ans:- D

57. A problem well put is …….
A. Fully solved
B. Not solved
C. Cannot be solved
D. half- solved
Ans:- D

58. ……. is a source of problem
A. Schools and Colleges
B. Class Room Lectures
C. Play grounds
D. Infra structures
Ans:- B

59. A question which requires a solution is …….
A. Observation
B. Problem
C. Data
D. Experiment
Ans:- B

60. Converting a question into a Researchable problem is called ……
A. Solution
B. Examination
C. Problem formulation
D. Problem Solving
Ans:- C

61. While Selecting a problem, problem which is ……. is no taken
A. Very Common
B. Overdone
C. Easy one
D. rare
Ans:- B

62. The first step in formulating a problem is
A. Statement of the problem
B. Gathering of Data
C. Measurement
D. Survey
Ans:- A

63. …….. will help in finding out a problem for research
A. Professor
B. Tutor

**C. HOD**
**D. Guide**
**Ans:- D**

**64. Second step in problem formulation is**
**A. Statement of the problem**
**B. Understanding the nature of the problem**
**C. Survey**
**D. Discussions**
**Ans:- B**

**65. Third step in problem formulation is**
**A. Statement of the problem**
**B. Understanding the nature of the problem**
**C. Survey the available literature**
**D. Discussion**
**Ans:- C**

**66. Fourth step in problem formulation is**
**A. Develop ideas through discussion**
**B. Survey**
**C. Statement of problem**
**D. Enactment**
**Ans:- A**

**67. Last step in problem formulation is**
**A. Survey**
**B. Discussion**
**C. Literature survey**
**D. Re Phrasing the Research problem**
**Ans:- D**

**68. In the formulation of the problem we need to give a …….**
**A. Title**
**B. Index**
**C. Bibliography**
**D. Concepts**
**Ans:- A**

**69. Objectives in problem formulation means**
**A. Questions to be answered**
**B. methods**
**C. Techniques**
**D. methodology**
**Ans:- A**

**70. The problem selected must have**
**A. Speed**
**B. Facts**
**C. Values**
**D. Novelty**
**Ans:- D**

**71. The formulated problem should have**
**A. Originality**

**B. Values**
**C. Coherence**
**D. Facts**
**Ans:- A**

**72. The purpose of Social Science Research is**
**A. Academic and Non academic**
**B. Cultivation**
**C. Academic**
**D. Utilitarian**
**Ans:- B**

**73. The Academic purpose is to have …….**
**A. Information**
**B. firsthand knowledge**
**C. Knowledge and information**
**D. models**
**Ans:- C**

**74. Social Science Research creates Social ……**
**A. Alienation**
**B. Cohesion**
**C. mobility**
**D. Integration**
**Ans:- B**

**75. …… is a quality of Good Researcher**
**A. Scientific temper**
**B. Age**
**C. Money**
**D. time**
**Ans:- A**

**76. Social Science Research in India aims at a ……. State**
**A. Secular**
**B. Totalitarian**
**C. democratic**
**D. welfare**
**Ans:- D**

**77. A …… is an abstraction formed by generalization from particulars**
**A. Hypothesis**
**B. Variable**
**C. Concept**
**D. facts**
**Ans:- C**

**78. Concept is of two types**
**A. Abstract and Coherent**
**B. Concrete and Coherent**
**C. Abstract and concrete**
**D. None of the above**
**Ans:- C**

**79. Concepts are of …….types**
**A. 4**
**B. 6**

**C. 10**
**D. 2**
**Ans:- D**

**80. There is a concept by ……**
**A. Observation**
**B. formulation**
**C. Theory**
**D. Postulation**
**Ans:- D**

**81. Another concept is by ……..**
**A. Formulation**
**B. Postulation**
**C. Intuition**
**D. Observation**
**Ans:- C**

**82. Concepts are ……. of Research**
**A. guide**
**B. tools**
**C. methods**
**D. Variables**
**Ans:- B**

**83. Concepts are …….**
**A. Metaphor**
**B. Simile**
**C. Symbols**
**D. Models**
**Ans:- C**

**84. Concepts represent various degree of ……..**
**A. Formulation**
**B. Calculation**
**C. Abstraction**
**D. Specification**
**Ans:- C**

**85. Concepts which cannot be given operational definitions are …… concepts**
**A. Verbal**
**B. Oral**
**C. Hypothetical**
**D. Operational**
**Ans:- C**

**86. "Concept is in reality a definition in short hand or a class or group of facts" –defined by**
**A. Kerlinger**
**B. P.V. Young**
**C. Aurthur**
**D. Kaplan**
**Ans:- B**

**87. Different people hold ……. of the same thing**
**A. Same and different**

**B. Same**
**C. different**
**D. None of the above**
**Ans:- C**

**88. Many concepts find their origin from**
**A. Greek**
**B. English**
**C. Latin**
**D. Many languages**
**Ans:-D**

**89. A tentative proposition subject to test is**
**A. Variable**
**B. Hypothesis**
**C. Data**
**D. Concept**
**Ans:- B**

**90. Analogies are sources of …….**
**A. Data**
**B. Concept**
**C. Research**
**D. Hypothesis**
**Ans:- D**

**91. "A Proposition which can be put to test to determine its validity" Defined by**
**A. Lund berg**
**B. Emory**
**C. Johnson**
**D. Good and Hatt**
**Ans:- D**

**92. " A tentative generalization" stated by**
**A. Good and Hatt**
**B. Lund berg**
**C. Emory**
**D. Orwell**
**Ans:- B**

**93. Propositions which describe the characteristics are ……. Hypothesis**
**A. Descriptive**
**B. Imaginative**
**C. Relational**
**D. Variable**
**Ans:- A**

**94. A Hypothesis which develops while planning the research is**
**A. Null Hypothesis**
**B. Working Hypothesis**
**C. Relational Hypothesis**
**D. Descriptive Hypothesis**
**Ans:- B**

**95. When a hypothesis is stated negatively it is called**
**A. Relational Hypothesis**
**B. Situational Hypothesis**
**C. Null Hypothesis**
**D. Casual Hypothesis**
**Ans:- C**

**96. The first variable is …….. variable**
**A. Abstract**
**B. Dependent**
**C. Independent**
**D. Separate**
**Ans:- C**

**97. The second variable is called ……**
**A. Independent**
**B. Dependent**
**C. Separate**
**D. Abstract**
**Ans:- B**

**98. Hypothesis which explain relationship between two variables is**
**A. Causal**
**B. Relational**
**C. Descriptive**
**D. Tentative**
**Ans:- B**

**99. Null means**
**A. One**
**B. Many**
**C. Zero**
**D. None of these**
**Ans:- C**

**100. ……. Represent common sense ideas**
**A. Statistical Hypothesis**
**B. Complex Hypothesis**
**C. Common sense Hypothesis**
**D. Analytical Hypothesis**
**Ans:- C**

**101. Which one of the following is regarded as the very breath of an experiment?**
**(a) Independent Variable**
**(b) Dependent Variable**
**(c) Controlled Variable**
**(d) Experimental Control**
**(e) None of the above**
**Ans:- D**

**102. When large groups of interconnected facts are considered together in a consistent manner, we get a/an:**
**(a) Scientific theory**
**(b) Non-scientific theory**

**(c) Social theory**
**(d) Authentic theory**
**(e) None of the above**
**Ans:- A**

**103. Experimental method starts with some problems which have:**
**(a) No solution for a brief time span**
**(b) No adequate solution**
**(c) An immediate solution**
**(d) No hypothesis**
**(e) None of the above**
**Ans:- B**

**104. When we assign numbers to objects, events or mental phenomena, we obtain a:**
**(a) Scale**
**(b) Rule**
**(c) Test**
**(d) Measure**
**(e) None of the above**
**Ans:- A**

**105. Interval Scales have:**
**(a) Equal appearing units**
**(b) No equal appearing units**
**(c) No statistical value**
**(d) No mathematical Design**
**(e) None of the above**
**Ans:- A**

**106. We find a true zero in a/an:**
**(a) Interval Scale**
**(b) Ordinal Scale**
**(c) Rating Scale**
**(d) Ratio Scale**
**(e) None of the above**
**Ans:- D**

**107. Method of rating or Method of successive catagories is otherwise called as:**
**(a) Interval Scale**
**(b) Method of Introspection**
**(c) Method of Observation**
**(d) Method of graded dichotomies**
**(e) None of the above**
**Ans:- D**

**108. The first rating scale was developed by:**
**(a) Starch (1910)**
**(b) Diggory (1953)**
**(c) Ebbinghaus (1885)**
**(d) Galton (1883)**
**(e) J. B. Watson (1913)**
**Ans:- D**

**109. The method of ranking was formerly known as the method of:**
**(a) Order of Merit**
**(b) Order of Steps**
**(c) Sequential Order**

**(d) Constant Intervals**
**(e) None of the above**
**Ans:- A**

**110. The method of 'paired comparison' was introduced by:**
**(a) Watson**
**(b) Galton**
**(c) Cohn**
**(d) Weber**
**(e) Fechner**
**Ans:- C**

**111. While studying colour preferences, the method of 'paired' comparison' was introduced by Cohn in:**
**(a) 1148 AD**
**(b) 1481 AD**
**(c) 1984 AD**
**(d) 1894 AD**
**(e) 1418 AD**
**Ans:- D**

**112. From the following, who is the first scientist to undertake systematic and statistical investigations of individual differences?**
**(a) 1. P. Pavlov**
**(b) C. E. Spearman**
**(c) J. B. Watson**
**(d) Francies Galton**
**(e) William Mc Dougall**
**Ans:- D**

**113. The term "mental tests" was first employed by:**
**(a) Spearman**
**(b) Binet**
**(c) James**
**(d) Cattell**
**(e) Mc Daugall**
**Ans:- A**

**114. According to P. T. Young, a comprehensive study of a social unit be that a person, a group, a social institution, a district or a community is called a:**
**(a) Case study**
**(b) Cultural study**
**(c) Class study**
**(d) Group Study**
**(e) None of the above**
**Ans:- A**

**115. Ex-Post Facto Research is a systematic empirical enquiry in which the scientist does not have direct control of:**
**(a) Independent Variables**
**(b) Dependent Variables**

**(c) Both Independent and Dependent Variables**
**(d) Controlled Variables**
**(e) None of the above**
**Ans:- A**

**116. A laboratory experiment is a research study in which the variance of all the possible influential independent variables not pertinent to the immediate problem of the investigations is kept at a:**
**(a) Maximum**
**(b) Constant level**
**(c) Highest Point**
**(d) Minimum**
**(e) None of the above**
**Ans:- D**

**117. A research study in a realistic situation in which one or more independent variables are manipulated by the experimenter under as carefully controlled conditions as the situation permit is known as:**
**(a) A field experiment**
**(b) A situational experiment**
**(c) A case study**
**(d) Observational study**
**(e) None of the above**
**Ans:- A**

**118. The variables in a field experiment operate more strongly than those used in:**
**(a) Case study**
**(b) Introspective method**
**(c) Laboratory Experiment**
**(d) Observational Method**
**(e) None of the above**
**Ans:- C**

**119. The field experiments have the advantage of investigating more fruitfully the dynamics of interrelationships of:**
**(a) Small groups of Variables**
**(b) Large groups of Variables**
**(c) Both small and large groups of Variables**
**(d) Independent Variables**
**(e) Dependent Variables**
**Ans:- A**

**120. Which type of research is approached through the methods of personal interviews, mailed questionnaires and personal discussions besides indirect oral investigation?**
**(a) Case Study**
**(b) Field Study**
**(c) Survey Research**

**(d) Observation**
**(e) Experimentation**
**Ans:- C**

**121. Which type of research is a product of developmental programming that has been adopted on a very large scale in the recent years more practically particularly after Second World War when most of the Third World Countries emerged on the development scene?**
**(a) Case Study**
**(b) Survey Research**
**(c) Experimentation**
**(d) Evaluation Research**
**(e) None of the above**
**Ans:- D**

**122. A research through launching of a direct action with the objective of obtaining workable solutions to the given problems is known as:**
**(a) Action Research**
**(b) Survey Research**
**(c) Evaluation Research**
**(d) Experimentation**
**(e) None of the above**
**Ans:- A**

**123. A proposition which can be put to determine its validity is called:**
**(a) Variable**
**(b) Error**
**(c) Hypothesis**
**(d) Problem**
**(e) None of the above**
**Ans:- C**

**124. The least noticeable value of a stimulus is called:**
**(a) Stimulus Threshold**
**(b) Response Threshold**
**(c) Hypothesis**
**(d) Problem**
**(e) None of the above**
**Ans:- A**

**125. Which method is regarded as the most preferred method of psychology?**
**(a) Observation**
**(b) Introspection**
**(c) Case Study**
**(d) Experimental Method**
**(e) Action Research**
**Ans:- D**

**126. "I bet this will happen if I do this" design of experimentation otherwise known as:**
**(a) Exploratory Experimentation**
**(b) Case Study**
**(c) Hypothesis Testing**

**(d) Survey Research**
**(e) None of the above**
**Ans:- C**

**127. To ensure that the influence of all relevant variables is the same for all the subjects and does not change during the experimental period is the main objective of:**
**(a) Experimental Error**
**(b) Experimental Control**
**(c) Experimental Variables**
**(d) Hypothesis Testing**
**(e) None of the above**
**Ans:- B**

**128. Field Study method is the method of:**
**(a) Laboratory Observation**
**(b) Situational Observation**
**(c) Naturalistic Observation**
**(d) Occasional Observation**
**(e) None of the above**
**Ans:- C**

**129. In studying the public opinion:**
**(a) Field Study method is applied**
**(b) Action Research is applied**
**(c) Survey Research is applied**
**(d) Scaling method is applied**
**(e) None of the above**
**Ans:- A**

**130. Which scale represents the lowest level of measurement and imparts the least information?**
**(a) Nominal Scale**
**(b) Ordinal Scale**
**(c) Interval Scale**
**(d) Ratio Scale**
**(e) None of the above**
**Ans:- A**

**131. Which Scale has an absolute zero at the point of origin?**
**(a) Ordinal Scale**
**(b) Interval Scale**
**(c) Nominal Scale**
**(d) Ratio Scale**
**(e) None of the above**
**Ans:- D**

**132. The method of selecting a portion of the universe with a view to drawing conclusion about the universe 'in toto' is known as:**
**(a) Scaling**
**(b) Leveling**
**(c) Randomizing**
**(d) Sampling**
**(e) None of the above**
**Ans:- D**

**133. How many samples out of 100 samples drawn from a given population, the researcher wants, should represent the true population estimates is known as:**
**(a) The confidence level**
**(b) The sampling level**
**(c) The situational level**
**(d) The experimental level**
**(e) None of the above**
**Ans:- A**

**134. The most common method of sampling in marketing researches and election polls is:**
**(a) Random Sampling**
**(b) Stratified Random Sampling**
**(c) Quota Sampling**
**(d) Proportionate Stratified Sampling**
**(e) Cluster Sampling**
**Ans:- C**

**135. Itemized rating scales are otherwise known as:**
**(a) Numerical Scales**
**(b) Rank Order Scales**
**(c) Graphic rating Scales**
**(d) Comparative Scales**
**(e) None of the above**
**Ans:- A**

**136. The men of medicine of the ancient as well as the modern tribal groups are masters in the techniques of:**
**(a) Suggestion and Hypnosis**
**(b) Experimentation**
**(c) Introspection**
**(d) Field Study**
**(e) None of the above**
**Ans:- A**

**137. In India, the first psychological laboratory was started in the year 1916 in Calcutta University and the second in 1923 in Mysore University. Both these laboratories are the result of the endeavour of:**
**(a) Prof. K. Kautilya**
**(b) Prof. B. Sinha**
**(c) Prof. B. N. Seal**
**(d) Prof. R. N. Rath**
**(e) None of the above**
**Ans:- C**

**138. In Observation Method, there is a tendency to read one's own thought and feeling into other's mind. This may be otherwise called:**
**(a) Projection**
**(b) Sublimation**
**(c) Identification**
**(d) Rationalization**

**(e) None of the above**
**Ans:- A**

**139. In the field of sensation, psychologists can easily gather valuable information's by the help of:**
**(a) Survey Method**
**(b) Introspection Method**
**(c) Experimentation**
**(d) Clinical Method**
**(e) None of the above**
**Ans:- B**

**140. When a person is becoming angry, if he starts observing and studying his state of mind simultaneously, he will not be able to show his anger. The moment he starts observing his own anger, it may subside. This problem can be partially solved by observing the experience after it is over. This is popularly known as:**
**(a) Retrospection**
**(b) Introjection**
**(c) Projection**
**(d) Identification**
**(e) None of the above**
**Ans:- A**

**141. There are some people in the world who can move objects which are away from them without using any form of physical force. In psychology, this phenomenon is called:**
**(a) Psychoanalysis**
**(b) Telepathy**
**(c) Precognition**
**(d) Psychokinesis**
**(e) Leviation**
**Ans:- D**

**142. The story of the Bible affirms that St. Peter walked on the surface of water. Among the Indian mystics, Padmapada, a disciple of Adi Sankar is reported to have walked across water, his steps being supported by lotus flowers. In psychology, this form of mysterious behaviour is popularly known as:**
**(a) Leviation**
**(b) Telepathy**
**(c) Psychokinesis**
**(d) Precognition**
**(e) None of the above.**
**Ans:- A**

**143. Some people are able to know and predict events long before**

**others can. This process is popularly known as:**
**(a) Telepathy**
**(b) Precognition**
**(c) Leviation**
**(d) Psychokinesis**
**(e) None of the above**
**Ans:- B**

**144. Some people in this world who are able to understand the thought processes of other individuals who are far away and perhaps even influence them without any form of contact. In psychology, this phenomenon is popularly known as:**
**(a) Telepathy**
**(b) Precognition**
**(c) Leviation**
**(d) Psychokinesis**
**(e) None of the above**
**Ans:- A**

**145. A recent development of "Applied Social Psychology" which is concerned with the application of psychology in solving the problems of particular communities of people like village community, the urban community and the socially backward community etc. is popularly known as:**
**(a) Community Psychology**
**(b) Group Psychology**
**(c) Educational Psychology**
**(d) Criminal Psychology**
**(e) None of the above**
**Ans:- A**

**146. Non-naturalistic observations on children may be contrived in a:**
**(a) Society**
**(b) Group**
**(c) Laboratory**
**(d) School**
**(e) None of the above**
**Ans:- C**

**147. Projective test is a:**
**(a) Non-naturalistic Observation**
**(b) Naturalistic Observation**
**(c) Self Observation**
**(d) Internal Observation**
**(e) None of the above**
**Ans:- A**

**148. The qualitative changes occurring in behavioural characteristics of the child leading towards maturity is otherwise known as:**
**(a) Development**
**(b) Growth**
**(c) Maturation**

**(d) Learning**
**(e) Intelligence**
**Ans:- A**

**149. The earlier concepts of "Child Development" started with the:**
**(a) Birth of the Child**
**(b) Death of the Child**
**(c) Conception**
**(d) Phallic Stage**
**(e) Second year of the Child**
**Ans:- A**

**150. The concept which refers to the consistency of scores obtained by the same persons when re-examined with the same test on different occasions is known as:**
**(a) Validity**
**(b) Reliability**
**(c) Standard Error**
**(d) Error Variance**
**(e) None of the above**
**Ans:- B**

**151. Experimental Analysis enables us to discern lawful relationships between antecedents and consequents involved in:**
**(a) Behaviour**
**(b) Experience**
**(c) Habit**
**(d) Attitude**
**(e) None of the above**
**Ans:- A**

**152. When large groups of interconnected facts are considered together in a consistent manner, we get a:**
**(a) Scientific Theory**
**(b) Critical Problem**
**(c) Combined Result**
**(d) Confirmed Fact**
**(e) None of the above**
**Ans:- A**

**153. Suppose you have a glass of milk and with a measuring glass you continue to add half a c.c. of plain tea at every step, till your friend reports a change in judgement in the colour of the milk. The quantity of tea added, has just crossed what is just termed as:**
**(a) Illusion**
**(b) Absolute Threshold**
**(c) Colour Blindness**
**(d) Just Noticeable Difference**
**(e) None of the above**
**Ans:- B**

**154. Suppose one Experimenter (E) in psychology firmly believes that**

**Brahmin children are inherently superior to the Harijan children. Naturally he would never think of home environment as an explanation. This is a very obvious example of:**
**(a) Experimenter's Bias**
**(b) Subject's Bias**
**(c) Stimulus Error**
**(d) Response Error**
**(e) None of the above**
**Ans:- A**

**155. Which one of the following approaches tries to analyze human behaviour in terms of stimulus-response units acquired through the process of learning, mainly through instrumental conditioning?**
**(a) Cognitive Approach**
**(b) Dynamic and Psychoanalytic Approach**
**(c) Stimulus-Response-Behaviouristic Approach**
**(d) Existential Approach**
**(e) Organismic, Wholistic and Self Approach**
**Ans:- C**

**156. The approach which has its roots in Gestalt Psychology is popularly known as:**
**(a) Wholistic Approach**
**(b) Stimulus-Response-Behaviouristic Approach**
**(c) Dynamic and Psychoanalytic Approach**
**(d) Cognitive Approach**
**(e) None of the above**
**Ans:- D**

**157. Which approach emphasises the role of instinctual processes and their modification in the course of interaction with the society?**
**(a) Dynamic and Psychoanalytic Approach**
**(b) Cognitive Approach**
**(c) Wholistic Approach**
**(d) Stimulus-Response-Behaviouristic Approach**
**(e) None of the above**
**Ans:- A**

**158. Which approach placed emphasis on human existence—the need to establish a sense of personal identity and to build meaningful links with the world?**
**(a) Cognitive Approach**
**(b) Dynamic and Psychoanalytic Approach**
**(c) Wholistic Approach**
**(d) Existential Approach**

**(e) None of the above**
**Ans:- D**

**159. Existentialism tries to reach modern man, offer him help in terms of clarifying his values, work out a meaningful and purposive existence. Psychologists who shaped this approach were:**
**(a) Rollo May, R. D. Laing and Erick Fromm**
**(b) G. W. Allport, R. B. Catell and H. J. Eysenk**
**(c) Erickson and Sullivan**
**(c) Piaget, Bruner and Witkin**
**(e) None of the above**
**Ans:- A**

**160. The system which still survives very nearly in its rigid forms is:**
**(a) Cognitive Approach**
**(b) Dynamic and Psychoanalytic Approach**
**(c) Wholistic Approach**
**(d) Existential Approach**
**(e) None of the above**
**Ans:- B**

**161. Which approach tells us that under normal conditions the Organism is not a passive recipient of stimuli but an active, seeking and striving entity trying to master the environment and also master itself?**
**(a) Organismic, Wholistic and Self Approaches**
**(b) Dynamic and Psychoanalytic Approach**
**(c) Cognitive Approach**
**(d) Existential Approach**
**(e) None of the Above**
**Ans:- A**

**162. Psychologists are sometimes interested to study consciousness even though they have no method of observing it directly except by using:**
**(a) 'Inference' as the only tool**
**(b) 'Experimentation' as the only tool**
**(c) 'Observation' technique**
**(d) 'Introspection' technique**
**(e) None of the above**
**Ans:- A**

**163. The term "unconscious motivation" describes the key idea of:**
**(a) Structuralism**
**(b) Functionalism**
**(c) Psychoanalysis**
**(d) Behaviourism**
**(e) None of the above**
**Ans:- C**

**164. The psychologists who are especially concerned with increasing the efficiency of learning in school by applying their psychological knowledge about learning and motivation to the curriculum are popularly known as :**
**(a) Experimental Psychologists**
**(b) Clinical Psychologists**
**(c) Physiological Psychologists**
**(d) Educational Psychologists**
**(e) Social Psychologists**
**Ans:- D**

**165. In some developed countries like U.S A. and U.K. many psychologists are engaged for diagnosing learning difficulties and trying to remedy them. These psychologists are popularly called:**
**(a) School Psychologists**
**(b) Social Psychologists**
**(c) Experimental Psychologists**
**(d) Industrial Psychologists**
**(e) Organisational Psychologists**
**Ans:- A**

**166. Today, private and public organizations also apply psychology to problems of management and employee training, to supervision of personnel, to improving communication within the organization, to counselling employees and to alleviating industrial strife. The applied psychologists who do this work are sometimes called:**
**(a) Personnel Psychologists**
**(b) Organizational Psychologists**
**(c) Experimental Psychologists**
**(d) Social Psychologists**
**(e) None of the above**
**Ans:- A**

**167. A person who uses the particular psychotherapeutic techniques which originated with Sigmund Freud and his followers is called:**
**(a) A psychoanalyst**
**(b) A psychiatrist**
**(c) A child psychologist**
**(d) A clinical psychologist**
**(e) None of the above**
**Ans:- A**

**168. Finding the causes of behaviour from a number of observations is called:**
**(a) Inductive reasoning**
**(b) Observational technique**
**(c) Deductive reasoning**
**(d) Introspection**

**(e) None of the above**
**Ans:- A**

**169. The clinical method is ordinarily used only when people come to psychologists with:**
**(a) Social problems**
**(b) Personal Problems**
**(c) Organizational problems**
**(d) Internal problems**
**(e) None of the above**
**Ans:- B**

**170. The technique of regulating various variables in an experiment is called:**
**(a) Independent Variable**
**(b) Dependent variable**
**(c) Experimental control**
**(d) Controlled variable**
**(e) None of the above**
**Ans:- C**

**171. Psychologists with the Biological perspective try to relate behaviour to functions of:**
**(a) Body**
**(b) Mind**
**(c) Soul**
**(d) Unconscious**
**(e) Subconscious**
**Ans:- A**

**172. A little girl Leny pushed Bapula, her brother, off his tricycle. She learned to behave this way because the behaviour paid off in the past, in other words, she learned to act aggressively in certain situations because she was rewarded for such behaviour in the past. With which perspective, a psychologist can study this type of problem?**
**(a) Biological Perspective**
**(b) Behavioural Perspective**
**(c) Cognitive Perspective**
**(d) Social Perspective**
**(e) Developmental Perspective**
**Ans:- B**

**173. The perspective which is concerned with characteristic changes that occur in people as they mature is known as:**
**(a) Developmental Perspective**
**(b) Biological Perspective**
**(c) Humanistic Perspective**
**(d) Psychoanalytic Perspective**
**(e) Cognitive Perspective**
**Ans:- A**

**174. A person's sense of self is emphasized by:**
**(a) Psychoanalytic Perspective**

**(b) Biological Perspective**
**(c) Developmental Perspective**
**(d) Cognitive Perspective**
**(e) Humanistic Perspective**
**Ans:- E**

**175. A key psychodynamic idea is that when unconscious impulses are unacceptable or when they make us anxious; to reduce anxiety, we use:**
**(a) Defense Mechanisms**
**(b) Super ego**
**(c) Instincts**
**(d) Dreams**
**(e) Frustration**
**Ans:- A**

**176. The distinction between a clinical psychologist and a psychiatrist is that:**
**(a) A clinical psychologist normally holds a Ph.D. or M.A. degree or Psy. D. (Doctor in Psychology) and a psychiatrist holds an MD degree**
**(b) A clinical psychologist holds a Ph.D. degree in Psychology and a psychiatrist holds both Psy. D. degree and Ph.D. degree**
**(c) A clinical psychologist holds a special degree in Psychology and a psychitrist holds a Ph.D. degree in Psychology**
**(d) A clinical psychologist has a special training in psychotherapy and a psychitrist holds M.A. degree in Psychology**
**(e) A clinical psychologist holds an M.A. degree in Psychology and a psychiatrist holds Ph.D. degree in Psychology**
**Ans:- A**

**177. The Subject "Psychology" was formally recognised in Germany in the year:**
**(a) 1789**
**(b) 1668**
**(c) 1879**
**(d) 1897**
**(e) 1968**
**Ans:- C**

**178. To study Abnormal Psychology means, to study mainly the nature of:**
**(a) Conscious Mind**
**(b) Unconscious Mind**
**(c) Subconscious Mind**
**(d) Normal Mind**
**(e) Abnormal Mind**
**Ans:- B**

**179. Sigmund Freud is regarded as the father of:**

(a) Psychoanalysis
(b) Behaviourism
(c) Functionalism
(d) Gestalt Psychology
(e) Stnicturalism
Ans:- A

180. The unit of Sociology is the 'Group', whereas the unit of Psychology is the:
(a) Stimulus
(b) Individual
(c) Animal
(d) Institution
(e) None of the above
Ans:- B

181. The branch of psychology which (teals with the study of animal behaviour is known as:
(a) Social Psychology
(b) Abnormal Psychology
(c) Differential Psychology
(d) Comparative Psychology
(e) None of the alxrve
Ans:- D

182. The father of 'Experimental Psychology' is:
(a) Wilhelm Wundt
(b) Sigmund Freud
(c) C.G. Jung
(d) E. B. Titchener
(e) William James
Ans:- A

183. For the first time, the word 'Psychology' was used by:
(a) Rudolf Goeckle
(b) Sigmund Freud
(c) William James
(d) E. B. Titchener
(e) C.G. Jung
Ans:- A

184. The literal meaning of 'Psychology' is:
(a) Science of Behaviour
(b) Science of Soul
(c) Science of Consciousness
(d) Science of Mind
(e) Science of Temperament
Ans:- B

185. Rudolf Goekle used the word 'Psychology' for the first time in:
(a) 1590 AD
(b) 1950 AD
(c) 1095 AD
(d) 1509 AD
(e) 1905 AD
Ans:- A

**186. Psychology as the 'Science of Mind' was defined by:**
**(a) Psychoanalysis**
**(b) Behaviourists**
**(c) Functionalists**
**(d) Ancient Greek Philosophers**
**(e) None of the above**
**Ans:- D**

**187. Scientific Psychology came into existence during:**
**(a) 19th Century**
**(b) 20th Century**
**(c) 18th Century**
**(d) 17th Century**
**(e) 15th Century**
**Ans:- A**

**188. E. B. Titchener (1867-1927) defined 'Psychology' as the science of:**
**(a) Soul**
**(b) Mind**
**(c) Experience**
**(d) Conscious Experience**
**(e) Behaviour**
**Ans:- D**

**189. J. B. Watson defined 'Psychology' as the science:**
**(a) Soul**
**(b) Behaviour**
**(c) Mind**
**(d) Consciousness**
**(e) Experience**
**Ans:- B**

**190. Psychology was defined as the "Science of Behaviour" by:**
**(a) Functionalists**
**(b) Structuralists**
**(c) Gestalt Psychologists**
**(d) Behaviourists**
**(e) None of the above**
**Ans:- D**

**191. Who defined 'Psychology' as the scientific study of activities of the organism in relation to its environment?**
**(a) J. B. Watson**
**(b) Sigmund Freud**
**(c) C. G. Jung**
**(d) William James**
**(e) Woodworth**
**Ans:- E**

**192. Any systematically organised body of verified knowledge about a certain class of facts and events is known as:**
**(a) Science**
**(b) Experiment**
**(c) Hypothesis**

(d) Fact
(e) Theory
Ans:- A

193. Psychology is:
(a) A social Science
(b) A Natural Science
(c) A Biological Science
(d) Both Natural and Social Science
(e) None of the above
Ans:- A

194. Behaviouristic School was established by:
(a) William James
(b) W. Kohler
(c) J.B. Watson
(d) K. Koffka
(e) I. P. Pavlov
Ans:- C

195. The most effective method of studying psychology is:
(a) Experimental Method
(b) Observation Method
(c) Introspection Method
(d) Survey Method
(e) Clinical Method
Ans:- A

196. Anything which evokes a response in the Organism is called:
(a) Stimulus
(b) Thing
(c) Situation
(d) Incidence
(e) None of the above
Ans:- A

197. A systematic study of facts according to a reliable and correct method of study is called a:
(a) Biological Study
(b) Social Technique
(c) Scientific Study
(d) Methodology
(e) None of the above
Ans:- C

198. That, which cannot be observed by another person, is called:
(a) Experience
(b) Activity
(c) Action
(d) Exercise
(e) Event
Ans:- A

199. The first psychological laboratory was established in Leipzig by Wilhelm Wundt in the year:
(a) 1789
(b) 1879
(c) 1899

**(d) 1798**
**(e) 1897**
**Ans:- B**

**200. "S-R" concept was first established by:**
**(a) J. B. Watson**
**(b) Wilhelm Wundt**
**(c) William James**
**(d) C. G. Jung**
**(e) 1. P. Pavlov**
**Ans:- A**

**201. Which of the following is not associated with use of the scientific method in psychological research? [TY2.1]**

a. **A commitment to producing knowledge through observation and experiment.**
b. **A commitment to basing knowledge exclusively on common sense and opinion.**
c. **A commitment to basing knowledge on empirical evidence.**
d. **A commitment to discovering truth.**
e. **A commitment to ensuring that findings are correctly interpreted.**

**Answer: B**

**202. Which of the following contribute to the development of knowledge and theory in psychology? [TY2.2]**

a. **Evidence that supports a hypothesis.**
b. **Evidence that contradicts a hypothesis.**
c. **Evidence that tests a hypothesis.**
d. **All of the above.**
e. **Answers (a) and (c) only.**

**Answer: D**

**203. Which of the following statements is true? [TY2.3]**

a. **If a finding is reliable it should be easy to replicate using the same procedures.**
b. **If a finding is reliable it will also be valid.**
c. **If a finding is reliable it will be important.**
d. **If a finding is reliable it must be an example of good scientific practice.**
e. **If a finding is reliable it has been correctly interpreted.**

**Answer: A**

**204. After reading some research on the topic of students' attitudes to university courses, Mark does a study to find out what students' favourite subject at university is. In this he finds that final-year psychology students prefer studying psychology to any other subject. On this basis he concludes that psychology is the most popular subject. However, Jane argues that this conclusion is wrong as the research actually shows that students prefer the subject they end up studying. What is the basis of her objection to Mark's research? [TY2.7]**

a. The study is invalid.
b. The study is unreliable.
c. The study is non-cumulative.
d. The study is unparsimonious.
e. None of the above.

**Answer: A**

**205. If an experimental finding is valid, which of the following statements is true?**

a. It should be easy to replicate
b. It supports a researcher's experimental predictions
c. It supports a researcher's theory
d. It occurred for the reason hypothesised by the researcher
e. It will make a demonstrable contribution to scientific knowledge

**Answer: D**

**206. Which of the following would not be of interest to a behaviourist?**

a. A person's reaction to a flashing light.
b. Differences in various people's responses to a flashing light.
c. The cognitive processes associated with reaction to a stimulus.
d. The impact of a particular stimulus on behaviour.
e. The different behaviours that arise from exposure to different stimuli.

**Answer: A**

**207. Which of the following is a physiological measure?**

a. A measure of blood flow through a person's brain.
b. Details of a person's family tree.

c. A person's response to questions on a survey.
d. A person's response to questions in an experiment.
e. The preference a person shows for one stimulus rather than another.

Answer: A

208. Theory A explains phenomenon L, phenomenon M and phenomenon N using principles J and K. Theory B explains phenomenon L, phenomenon M, and phenomenon N using only principle K. Theory C explains phenomenon L and phenomenon N using principles J and K. Which of the following statements is true?

a. Theory A is the most parsimonious.
b. Theory B is the most parsimonious.
c. Theory C is the most parsimonious.
d. Theory A and Theory C are equally and most parsimonious.
e. Theory A and Theory B are equally and most parsimonious.

Answer: B

209. "An argument in which the thing to be explained is presented as the explanation (e.g. where memory ability is used to explain memory performance)." What type of argument is this a glossary definition of?

a. Conceptual argument
b. Convenient argument
c. Causal argument
d. Circular argument
e. Casual argument

Answer: D

210. "The goal of accounting for the maximum number of empirical findings in terms of the smallest number of theoretical principles." This a glossary definition of which principle?

a. Maximization.
b. Parsimony.
c. Reliability.
d. Validity.
e. External validity.

Answer: B

211. "Formally, a statement about the causal relationship between particular phenomena (i.e. in the form 'A causes B'). This is usually

**derived from a particular theory and designed to be tested in research." Which construct is this a glossary definition of?**

a. **Prediction.**
b. **Deduction.**
c. **Hypothesis.**
d. **Conventional reasoning.**
e. **Deductive reasoning.**

**Answer: C**

**212. "Treating an abstraction as if it were a real concrete thing. In psychology this refers to the process and outcome of treating an empirical finding as if it were the straightforward expression of an underlying psychological process (e.g. seeing performance on intelligence tests as the expression of intelligence)." This a glossary definition of which process?**

a. **Reification.**
b. **Refutation**
c. **Concretization.**
d. **False consensus.**
e. **Exprimental artifice.**

**Answer: A**

**213. Which of the following statements is not true? [TY3.1]**

a. **Psychological measurement can involve the measurement of phenomena believed to be related to a given psychological state or process.**
b. **Psychological measurement can involve the measurement of behaviour believed to result from a given psychological state or process.**
c. **Psychological measurement can involve self-reports of behaviour believed to be related to a given psychological state or process.**
d. **Psychological measurement can involve the self-reports of a sample drawn from a particular sub-population.**
e. **Psychological measurement can involve direct examination of psychological states and processes.**

**Answer: E**

**214. A researcher conducts an experiment that tests the hypothesis that 'anxiety has an adverse effect on students' exam performance'. Which of the following statements is true? [TY3.2]**

a. Anxiety is the dependent variable, exam performance is the independent variable.
b. Anxiety is the dependent variable, students are the independent variable.
c. Anxiety is the independent variable, students are the dependent variable.
d. Anxiety is the independent variable, exam performance is the dependent variable.
e. Students are the dependent variable, exam performance is the independent variable.

Answer: D

215. An experimenter conducts a study in which she wants to look at the effects of altitude on psychological well-being. To do this she randomly allocates people to two groups and takes one group up in a plane to a height of 1000 metres and leaves the other group in the airport terminal as a control group. When the plane is in the air she seeks to establish the psychological well-being of both groups. Which of the following is a potential confound, threatening the internal validity of the study? [TY3.3]

a. The reliability of the questionnaire that she uses to establish psychological health.
b. The size of the space in which the participants are confined.
c. The susceptibility of the experimental group to altitude sickness.
d. The susceptibility of the control group to altitude sickness.
e. The age of people in experimental and control groups.

Answer: B

216. What distinguishes the experimental method from the quasi-experimental method? [TY3.4]

a. The scientific status of the research.
b. The existence of an independent variable.
c. The existence of different levels of an independent variable.
d. The sensitivity of the dependent variable.
e. The random assignment of participants to conditions.

Answer: E

**217. Which of the following is not an advantage of the survey/correlational method? [TY3.5]**

a. It allows researchers to examine a number of different variables at the same time.
b. It allows researchers to examine the relationship between variables in natural settings.
c. It allows researchers to make predictions based on observed relationships between variables.
d. It allows researchers to explain observed relationships between variables.
e. It is often more convenient than experimental methods.

**Answer: D**

**218. Which of the following statements is true? [TY3.6]**

a. Case studies have played no role in the development of psychological theory.
b. Case studies have all of the weaknesses and none of the strengths of larger studies.
c. Case studies have none of the weaknesses and all of the strengths of larger studies.
d. Case studies should only be conducted if every other option has been ruled out.
e. None of the above.

**Answer: E**

**219. An experimenter, Tom, conducts an experiment to see whether accuracy of responding and reaction time are affected by consumption of alcohol. To do this, Tom conducts a study in which students at university A react to pairs of symbols by saying 'same' or 'different' after consuming two glasses of water and students at university B react to pairs of symbols by saying 'same' or 'different' after consuming two glasses of wine. Tom predicts that reaction times will be slower and that there will be more errors in the responses of students who have consumed alcohol. Which of the following statements is not true? [TY3.7]**

a. The university attended by participants is a confound.
b. The experiment has two dependent variables.

c. Reaction time is the independent variable.
d. Tom's ability to draw firm conclusions about the impact of alcohol on reaction time would be improved by assigning participants randomly to experimental conditions.
e. This study is actually a quasi-experiment.

**Answer: C**

**220. What is an extraneous variable? [TY3.8]**

a. A variable that can never be manipulated.
b. A variable that can never be controlled.
c. A variable that can never be measured.
d. A variable that clouds the interpretation of results.
e. None of the above.

**Answer: D**

**221. Which of the following statements is true? [TY3.9]**

a. The appropriateness of any research method is always determined by the research question and the research environment.
b. Good experiments all involve a large number of participants.
c. Experiments should be conducted in laboratories in order to improve experimental control.
d. Surveys have no place in good psychological research.
e. Case studies are usually carried out when researchers are too lazy to find enough participants.

**Answer: A**

**222. A piece of research that is conducted in a natural (non-artificial) setting is called: [TY3.10]**

a. A case study.
b. A field study.
c. A quasi-experiment.
d. A survey.
e. An observational study.

**Answer: B**

**223. "Measures designed to gain insight into particular psychological states or processes that involve recording performance on particular activities or tasks." What type of**

**measures does this glossary entry describe?**

a. **State measures.**
b. **Behavioural measures.**
c. **Physiological measures.**
d. **Activity measures.**
e. **Performance measures.**

**Answer: B**

**224. "An approach to psychology that asserts that human behaviour can be understood in terms of directly observable relationships (in particular, between a stimulus and a response) without having to refer to underlying mental states." Which approach to psychology is this a glossary definition of?**

a. **Behaviourism.**
b. **Freudianism.**
c. **Cognitivism.**
d. **Radical observationism.**
e. **Marxism.**

**Answer: A**

**225. "The complete set of events, people or things that a researcher is interested in and from which any sample is taken." What does this glossary entry define?**

a. **Total sample.**
b. **Complete sample.**
c. **Reference sample.**
d. **Reference group.**
e. **Population.**

**Answer: E**

**226. "Either the process of reaching conclusions about the effect of one variable on another, or the outcome of such a process." What does this glossary entry define?**

a. **Causal inference.**
b. **Induction.**
c. **Deduction.**
d. **Inductive reasoning.**
e. **Inferential accounting.**

**Answer: A**

**227. "The extent to which the effect of an independent variable on a dependent variable has been correctly interpreted." Which construct is this a glossary definition of?**

a. **Internal inference.**
b. **External inference.**
c. **External validity.**
d. **Holistic deduction.**
e. **Internal validity.**

**Answer: E**

**228. What is a manipulation check and what is its purpose? [TY4.1]**

a. A dependent measure used to check that manipulation of an independent variable has been successful.
b. An independent variable used to check that measurement of a dependent variable has been successful.
c. A measure used to check that an experiment has an independent variable.
d. An independent measure used to check that the operationalization is relevant.
e. A dependent measure used to check that an independent variable is sufficiently relevant.

**Answer: A**

**229. Which of the following statements is true? [TY4.2]**

a. Dependent variables that do not measure the most relevant theoretical variable are pointless.
b. A study that employs dependent variables that are sensitive enough to detect variation in the independent variable is a quasi-experiment.
c. Unless dependent variables are sufficiently sensitive they will not reveal the effects of manipulating an independent variable.
d. Unless dependent variables are sufficiently relevant they will not reveal the effects of manipulating an independent variable.
e. None of the above.

**Answer: C**

**230. A team of researchers is interested in conducting an experiment in order to test an important theory. In order to draw appropriate conclusions from any experiment they conduct, which of the following statements is true? [TY4.3]**

a. The experimental sample must be representative of the population to which they want to generalize the research on dimensions of age, sex and intelligence.
b. The experimental sample must be representative of the population to which they want to generalize the research on all dimensions.

c. The experimental sample must be representative of the population to which they want to generalize the research on all dimensions that can be measured in that population.
d. The experimental sample must be representative of the population to which they want to generalize the research on all dimensions relevant to the process being studied.
e. None of the above.

**Answer: D**

**231. An experimenter conducts a study examining the effects of television violence on children's aggressiveness. To do this she asks 40 schoolboys who display normal levels of aggressiveness to watch one violent video a week for 40 weeks. On a standard measure of aggressiveness, which she administers both before and after each video over the 40-week treatment, she finds that the boys are much more aggressive in the last 10 weeks of the study. Without knowing anything more about this study, which of the following can be ruled out as a threat to the internal validity of any conclusions she may seek to draw? [TY4.4]**

a. History effects.
b. Maturation effects.
c. Mortality effects.
d. Regression to the mean.
e. Testing effects.

**Answer: D**

**232. Which of the following can increase a researcher's ability to generalize findings from a particular piece of research? [TY4.5]**

a. Cheating.
b. Experimenter bias.
c. Deception and concealment.
d. Participants' sensitivity to demand characteristics.
e. The use of unrepresentative samples.

**Answer: C**

**233. A researcher conducts an experiment to investigate the effects of positive mood on memory. Mood is manipulated by giving participants a gift. In the experiment, before they are given a memory test, half of the participants are randomly assigned to a condition in which they are given a box of chocolates, and the other half are given nothing. Which**

**of the following statements is not true? [TY4.6]**

a. **Mood is a between-subjects variable.**
b. **The experiment has two conditions.**
c. **The experiment includes a control condition.**
d. **The independent variable is manipulated within subjects.**
e. **Experimental control eliminates potential threats to the internal validity of the experiment.**

**Answer: D**

**234. Which of the following is a researcher's overall objective in using matching? [TY4.7]**

a. **To control for extraneous variables in quasi-experimental designs.**
b. **To increase participants' enjoyment of correlational research.**
c. **To ensure that participants are randomly assigned to conditions.**
d. **To ensure that groups of participants do not differ in age and sex.**
e. **To ensure that groups of participants do not differ in intelligence.**

**Answer: A**

**235. Which of the following threats to validity is the most difficult to control by improving experimental design? [TY4.8]**

a. **Maturation effects.**
b. **Cheating by experimenters.**
c. **History effects.**
d. **Sensitivity to demand characteristics.**
e. **Experimenter bias.**

**Answer: B**

**236. Some researchers decided to conduct an experiment to investigate the effects of a new psychological therapy on people's self-esteem. To do this they asked all their clients who were currently receiving treatment for low self-esteem to continue using an old therapy but treated all their new clients with the new therapy. A year later they found that clients subjected to the new therapy had much higher self-esteem. Which of the following statements is true? [TY4.9]**

a. The greater self-esteem of the clients exposed to the new therapy resulted from the superiority of that therapy.
b. The greater self-esteem of the clients exposed to the new therapy resulted from the fact that the new clients were more optimistic than those who were previously receiving treatment.
c. The greater self-esteem of the clients exposed to the new therapy resulted from the fact that the new clients were less disillusioned with therapy than those who were previously receiving treatment.
d. The greater self-esteem of the clients exposed to the new therapy resulted from the fact that the new clients were more intelligent than those who were previously receiving treatment.
e. It is impossible to establish the validity of any of the above statements based on the results of this study.

**Answer: E**

**237. An experimenter conducts an experiment to see whether people's reaction time is affected by their consumption of alcohol. To do this, she conducts a study in which students from University A describe symbols as 'red' 'green' or 'blue' before they consume two glasses of wine and students from University B describe symbols as 'red' 'green' or 'blue' after they consume two glasses of wine. She hypothesizes that reaction times will be slower and that there will be more errors in the responses of students who consume alcohol before reacting to the symbols. Which of the following statements is false?**

a. It is appropriate to analyse the results using independent sample t-tests
b. Type of University is a potential experimental confound
c. The experiment has two dependent variables
d. The experiment has three independent variables
e. The experiment has a between-subjects design.

**Answer: D**

**238. "Both (a) the process of constructing experiments and (b) the resulting structure of those experiments." What research feature is this a glossary definition of?**

a. Experimental design.
b. Constructive design.
c. Experimental structuration.
d. Solidification.
e. Experimental procedure.

**Answer: A**

**239. "A system for deciding how to arrange objects or events in a progressive series. These are used to assign relative magnitude to psychological and behavioural phenomena (e.g. intelligence or political attitudes)." What is this a glossary definition of?**

a. A scale.
b. A measure.
c. A measurement.
d. A callibration.
e. A test.

**Answer: A**

**240. "The principle that the more relevant a dependent variable is to the issue in which a researcher is interested, the less sensitive it may be to variation in the independent variable." What is this a glossary definition of?**

a. Systematic desensitization.
b. Random variation.
c. Meaurement error.
d. Relevance–sensitivity trade-off.
e. Inferential uncertainty.

**Answer: D**

**241. "The extent to which a research finding can be generalized to other situations." What is this a glossary definition of?**

a. External validity
b. Generalization.
c. Induction.
d. Extendability.
e. Empirical applicability.

**Answer: A**

**242. "Systematic change to an independent variable where the same participants are exposed to different levels of that variable by the experimenter." What procedure is this a glossary definition of?**

a. Random assignment.
b. Within-subjects manipulation.

c. Between-subjects manipulation.
d. Variable assignment.
e. Experimenter manipulation.

Answer: B

243. Surveys are preferred in some areas of psychology for which of the following reasons? [TY5.1]

a. They are usually cheaper.
b. They allow researchers to infer causal relationships.
c. They are more scientific because similar methods are used in astronomy and geology.
d. It is often impossible to manipulate the independent variables the researchers are interested in.
e. They use randomization to achieve random sampling.

Answer: D

244. A television news programme shows a murder case including video footage of the grieving parents of the victim. The television station then conducts an opinion poll in which it asks viewers to phone in and vote for or against the death penalty for murder. The results of the survey show that 83% of the 20,000 viewers who ring in are in favour of the death penalty. Which of the following statements is true? [TY5.2]

a. The results of this study can only be generalized to people who watch news programmes.
b. The results of this study can only be generalized to people who own a television.
c. The results of this study can only be generalized to people who care about the death penalty.
d. The results of this study can only be generalized when we know much more about the sampling method.
e. The results of this study can only be generalized if the bias created by showing the grieving parents is eliminated.

Answer: D

245. Which of the following can be a threat to the internal validity of longitudinal studies? [TY5.3]

a. Testing effects.
b. The IQ of the participants.
c. Sample size.
d. Maturation effects.

e. Both (a) and (d).

**Answer: E**

**246. Which of the following statements is true? [TY5.4]**

a. Questionnaires should not ask people to provide personal information.
b. Questionnaires should aim to obtain as much information from people as possible.
c. The order of items in a questionnaire is not particularly important.
d. Questionnaires should contain a mixture of open-ended and forced-choice items.
e. None of the above.

**Answer: E**

**247. In a survey where the results are obtained from a representative random sample of a population, which of the following is true? [TY5.5]**

a. The results can be generalized to that population.
b. The sample can only be obtained by simple random sampling.
c. The sampling procedure is similar to that used in most experimental research.
d. Both (a) and (b).
e. None of the above.

**Answer: A**

**248. Which of the following statements about convenience sampling is true? [TY5.6]**

a. It should always be avoided.
b. It is appropriate providing the sample size is extremely large.
c. It can be used under some circumstances.
d. It is a non-probability sampling technique.
e. Both (c) and (d).

**Answer: E**

**249. Which of the following is likely to be a problem for non-reactive studies that use non-obtrusive measures? [TY5.7]**

a. Social desirability effects.
b. Defining the probability of maturation for each member of the population.
c. Appropriate operationalization of variables.
d. Behavioural traces.

e. Both (c) and (d).

**Answer: C**

**250. A team of researchers conducts a study in which they ask boys and girls from a local high school to complete a battery of psychological tests that investigate their social skills and levels of sociability. Ten years later they ask boys and girls from the same school to perform the same tests. Which of the following statements is false? [TY5.8]**

a. The study has a successive cross-sectional design.
b. The research is invalid because developmental studies should not include psychological tests.
c. Testing effects are eliminated by using a between-subjects design.
d. Mortality effects are eliminated by using a between-subjects design.
e. Maturation effects are eliminated by using a between-subjects design.

**Answer: B**

**251. Which of the following statements is most correct?**

a. The use of unobtrusive measures in surveys helps deal with reactivity.
b. The use of unobtrusive measures in surveys helps deal with standardization.
c. The use of unobtrusive measures in surveys helps deal with social desirability.
d. The use of unobtrusive measures in surveys helps deal with reactivity and social desirability.
e. The use of unobtrusive measures in surveys helps deal with reactivity, standardization and social desirability.

**Answer: D**

**252. A researcher conducts a research project in which she surveys all the members of her local golf club. This is most likely to be an example of which of the following?**

a. Purposive sampling.
b. Random sampling.
c. Simple random sampling.
d. Split ballot sampling.
e. None of the above.

**Answer: A**

**253. "The extent to which people's behaviour appears acceptable to other people. If behaviour is affected by people trying to behave in ways that they perceive to be desirable to the researcher then this threatens both the internal and external validity of research." What construct does this glossary entry define?**

a. Social desirability.
b. Self-presentation.
c. Deception.
d. Experimenter bias.
e. Participant bias.

**Answer: A**

**254. "A listing of all members of the population of interest." What is this a glossary definition of?**

a. A sample brochure.
b. A population directory.
c. A sampling directory.
d. A sampling frame.
e. A full sample specification.

**Answer: D**

**255. "A preliminary piece of research designed to 'road-test' various design elements (e.g. independent variables, dependent variables, details of procedure), in order to establish their viability and utility prior to the investment of time and money in a full study." What type of study does this glassary entry define?**

a. A sampling study.
b. A replication study.
c. A pre-test.
d. A pilot study.
e. A viability study.

**Answer: D**

**256. "Studies where the same sample of participants is measured on more than one occasion." What type of study is this a glossary definition of?**

a. Longitudinal surveys
b. Carry-over surveys
c. Repeated-measures surveys
d. Cohort surveys
e. Population censuses

**Answer: A**

**257. "Questionnaire items where a respondent has to select one response from two or more options." What type of response is this a glossary definition of?**

a. Selective response.
b. Forced-choice response.
c. Free response.
d. Likert-scale response.

e. Double-barrelled response.

Answer: B

258. A researcher conducts an experiment in which she assigns participants to one of two groups and exposes the two groups to different doses of a particular drug. She then gets the participants to learn a list of 20 words and two days later sees how many they can recall. In the experiment the dependent measure is simply the number of words recalled by each participant. What type of dependent measure is this? [TY6.1]

a. Nominal.
b. Ordinal.
c. Interval.
d. Ratio.
e. None of the above.

Answer: D

259. A researcher conducts a study to find out how many times people had visited a doctor in the previous year. Five people participated in the study and the numbers of visits they had made were 2, 5, 7, 4 and 2. Which of the following statements is true? [TY6.2]

a. The mean number of visits is 2.
b. The median number of visits is 2.
c. The median number of visits is 4.
d. The modal number of visits is 4.
e. The modal number of visits is 7.

Answer: C

260. Which of the following statements is most likely to be true if the distribution of a variable is severely skewed? [TY6.3]

a. The mean will be the best measure of central tendency.
b. The median will be as misleading as the mean.
c. The mode will no longer be the most common response.
d. The median will be the best measure of central tendency.
e. The mode will be the best measure of central tendency.

Answer: D

261. If X is a variable, which of the following is not measured in the same units as X? [TY6.4]

a. The mean of X.

b. The range of X.
c. The standard deviation of X.
d. The variance of X.
e. The difference between minimum and maximum values of X.

**Answer: D**

**262. If scores on a variable are normally distributed, which of the following statements is false?**

a. All scores on the variable will have been observed with equal frequency.
b. The distribution of scores is symmetrical about the mean.
c. Similar distributions are commonly observed in data obtained from psychological research.
d. There will be relatively few extreme scores.
e. The mean, median and modal scores will be equal.

**Answer: A**

**263. Which of the following is not a measure of central tendency?**

a. The mean of a distribution.
b. The mean squared deviation of some data.
c. The modal value of a set of values.
d. The median response on a scale.
e. An average score.

**Answer: B**

**264. The shaded bars in the histogram below represent the times (rounded to the nearest 10 milliseconds) that 50 people take to react to a loud noise. Which of the following statements is not true?**

a. The distribution of reaction times is negatively skewed.
b. The modal reaction time is 240 ms.
c. The median reaction time is greater than 240 ms.
d. The mean reaction time will be greater than the modal reaction time.
e. The mean is an ambiguous measure of central tendency.

**Answer: A**

**265. 'Root mean squared deviate' could be used as another name for which measure of dispersion?**

a. Range.
b. Skewness
c. Variance.

d. Standard deviation.
e. Squared deviation from the root.

**Answer: D**

**266. A researcher measures a variable whose distribution she observes to be normally distributed. On this basis which of the following statements is most likely to be true?**

a. The distribution's mean will be greater than its median and mode.
b. The distribution's median will be greater than its mean and mode.
c. The distribution's mean will be similar to its median and mode.
d. The distribution's mean will be less than its median and mode.
e. The distribution's mean will be greater than its median but less than its mode.

**Answer: C**

**267. Which of the following is a measure of central tendency?**

a. The variance in scores obtained on a dependent measure.
b. The mean deviation of some data.
c. Standard deviation.
d. The range of a set of values.
e. None of the above.

**Answer: E**

**268. The SPSS output below is from a study in which the scores for the variable "Survey_Point" could vary between 0 and 30. Looking at the distribution of frequencies, which of the following statements is true?**

a. The distribution of scores is positively skewed.
b. The distribution of scores is negatively skewed.
c. There is a uniform distribution of scores.
d. The data have a bimodal distribution.
e. None of the above.

**Answer: B**

**269. The SPSS output below is from a study in which the scores for the variable "Survey_Point" could vary between 0 and 30. Looking at the distribution of frequencies, which of the following statements is true?**

a. The mean will be higher than the mode.
b. The mode will be higher than the mean.
c. The mean will be the same as the mode.
d. The median will be lower than the mean.
e. The median will be higher than the mode.

Answer: B

270. "A variable that can be treated as if there were no breaks or steps between its different levels (e.g., reaction time in milliseconds)." What type of variable is this a glossary definition of?

a. A logical variable.
b. A discrete variable.
c. A scale variable.
d. A continuous variable.
e. A measurement variable.

Answer: D

271. "A measure reflecting distinct categories that have different names but the categories are not numerically related to one another." What type of measure is this a glossary definition of?

a. An ordinal measure.
b. A nominal measure.
c. A scale measure.
d. A desperate measure.
e. A ratio measure.

Answer: B

272. "The spread of scores across levels of a variable." What is this a glossary definition of?

a. Distribution.
b. Range.
c. Variance.
d. Covariance.
e. Standard deviation.

Answer: A

273. "Scores that are very different from the typical value for a distribution. Because they are very different from the central tendency of a distribution they contribute a great deal to the amount of dispersion in the distribution." What does this glossary entry define?

a. Deviates.
b. Mean deviates.
c. Outliers
d. Non-respondents.
e. Missing data.

Answer: C

**274. Which of the following statements is/are true about the t-distribution? [TY8.1]**

a. Its shape changes with the number of degrees of freedom.
b. Its expected value is 0.
c. It can be used to test differences between means providing that the population standard deviation is known.
d. Both (a) and (b).
e. All of the above.

**Answer: D**

**275. The mean height of a sample of 100 men in 2014 is 180 cm, with a standard deviation of 10 cm. The mean for the same population in 1914 was 170 cm. Imagine that we want to use the 2014 sample to test whether the height of the population has changed over the intervening 100 years. Which of the following statements is true? [TY8.2]**

a. The number of degrees of freedom for the test in this case is 99.
b. The t-value is 10.0.
c. The t-value corresponds to a very small probability that a random process of taking samples of 100 men from a population similar to the 1914 population would produce a sample of 180 cm or taller.
d. All of the above.
e. Answers (a) and (b) only.

**Answer: D**

**276. Which of the following is not relevant to a between-subjects t-test? [TY8.3]**

a. The pooled variance estimate.
b. A difference score D.
c. An information term.
d. A sampling distribution of the differences between means.
e. A probability that a difference of the same size or larger could be obtained by a random process.

**Answer: B**

**277. If an experimenter conducts a t-test to see whether the responses of participants in a control group differ from those of an experimental group, which of the following outcomes will yield the highest t-value? [TY8.4]**

a. If there are 10 participants in each condition and the difference between the mean

responses of the control group and the experimental group is 2 and both have standard deviations of 1.

b. If there are 10 participants in each condition and the difference between the mean responses of the control group and the experimental group is 2 and both have standard deviations of 2.

c. If there are 20 participants in each condition and the difference between the mean responses of the control group and the experimental group is 1 and both have standard deviations of 1.

d. If there are 20 participants in each condition and the difference between the mean responses of the control group and the experimental group is 2 and both have standard deviations of 1.

e. If there are 20 participants in each condition and the difference between the mean responses of the control group and the experimental group is 2 and both have standard deviations of 2.

Answer: D

278. Which of the following must be true of a statistically significant result of a t-test? [TY8.5]

a. The probability that a difference at least as large as the observed difference could be produced by a particular random process will be less than the alpha level.
b. The obtained value of t will exceed the alpha level.
c. The rejection regions must be significantly different from each other.
d. Both (a) and (c).
e. Alpha must be set at .05.

Answer: A

279. Researchers conduct a t-test and obtain a p-value of .0012. Which of the following is an appropriate conclusion on the basis of the information provided? [TY8.6]

a. The result is significant.
b. The effect size will be large.
c. Both (a) and (b).
d. A 99% confidence interval for the differences between the means will include the observed difference.

e. A 95% confidence interval for the differences between the means will not include the observed difference.

Answer: E

280. Researchers conduct a t-test to compare two groups and find that one of the groups has a much larger standard deviation than the other. Which of the following statements is true? [TY8.7]

a. The variances are robust.
b. The assumption of equal variance may have been violated.
c. The researchers should make sure that their distributions are free of parameters.
d. The standard deviations are not normal.
e. Both (b) and (d).

Answer: B

281. If an experimenter were to conduct an experiment in which participants were randomly assigned to either a control condition or an experimental condition, which of the following statements would be true? [TY8.8]

a. It will be appropriate to analyse results using a between-subjects t-test.
b. Any statistical analysis will be based on pairs of responses.
c. If a t-test is performed to analyse the results, it will have n − 1 degrees of freedom.
d. The experiment involves two related samples.
e. Both (a) and (c).

Answer: A

282. John, a second-year psychology student, is using the hypothesis-testing approach and an alpha level of .05 to examine a difference between two means. He discovers that this difference is associated with a t-value of 3.46. If the critical t-value with $\alpha = .05$ is 2.056 what should he conclude? [TY8.9]

a. That the difference between the means is statistically significant.
b. That the alpha level is too high.
c. That the alpha level is not high enough.

d. That the experiment did not contain enough participants to draw a strong conclusion.
e. That no conclusion can be made about the nature of the underlying populations.

**Answer: A**

**283. Which of the following suggests that the assumptions underlying a between-subjects t-test have been violated? [TY8.10]**

a. Evidence that the dependent variable is normally distributed.
b. Evidence that the samples being compared have unequal variances.
c. Evidence that the manipulation of the independent variable had no effect.
d. Evidence that sampling was random, and that scores were independent.
e. None of the above.

**Answer: B**

**284. Which of the following increases the likelihood of a Type II error when conducting a t-test? [TY8.11]**

a. A high alpha level.
b. A large sample size.
c. High power.
d. Low random error.
e. A small difference between means.

**Answer: E**

**285. An experimenter conducts an experiment using a control group containing 8 subjects and an experimental group containing 8 subjects. How many degrees of freedom are there in this experimental design?**

a. 7
b. 8
c. 14
d. 15
e. 16

**Answer: C**

**286. The graph below was generated by SPSS and plots participants' scoreson the variable "Survey_Point" which can vary between 0 and 30. Looking at this graph, what might make these data inappropriate to analyse using a t-test?**

a. The assumption of independence is violated.
b. The assumption of normality is violated.
c. The assumption of equal variance is violated.
d. Both (a) and (b).
e. Both (b) and (c).

Answer: B

287. "The probability, as revealed by a statistical test, that a random process (involving taking random samples of a particular size from a particular population) could produce some outcome." What is this a glossary definition of?

a. Random error
b. Sampling error
c. The random value
d. The p-value
e. The q-value

Answer: D

288. "An outcome where the probability that an effect at least as large as that observed could be produced by a random process is less than a predetermined alpha level. This means that it is implausible that a random process could have produced the effect." Which construct is this a glossary definition of?

a. Statistical significance.
b. Power.
c. Type I error.
d. Type II error .
e. Random error.

Answer: A

289. "The mistaken idea that random events are not independent. A gambler may believe that a long run of good or bad luck has to change. The gambler's fallacy arises from a misunderstanding of the law of large numbers. The idea that a random process will behave in a predictable way on average over a long run of observations can be misunderstood to imply that there is 'a law of averages' that serves to change the probability of random events based on past events. However, coins, dice and other things that generate random outcomes do not have memories." What type of fallacy is this a glossary definition of?

a. The significance fallacy.
b. The gambler's fallacy.
c. The causal fallacy.
d. The operational fallacy.

e. The psychological fallacy.

**Answer: B**

**290. Which of the following statements is true? [TY9.1**

a. A negative correlation is the same as no correlation.
b. Scatterplots are a very poor way to show correlations.
c. If the points on a scatterplot are close to a straight line there will be a positive correlation.
d. Negative correlations are of no use for predictive purposes.
e. None of the above.

**Answer: E**

**291. If a calculation of Pearson's r yields a value of −.96, which of the following statements is false? [TY9.2]**

a. The observed correlation between variables is negative.
b. There is a small amount of negative covariance between variables relative to random error.
c. A high score on one variable is associated with a low score on the other.
d. This correlation is useful for predictive purposes.
e. Points on a scatterplot would resemble a straight line.

**Answer: B**

**292. As part of a psychology assignment Kate has to calculate Pearson's r to measure the strength of association between two variables. She finds that r = −.2 and that this is significant at her selected alpha level of .05. What should she conclude? [TY9.3]**

a. That there is a significant but small relationship between the two variables.
b. That there is a non-significant but large relationship between the variables.
c. That there is a significant and moderate relationship between the variables.
d. That the two variables are unrelated.
e. That variation in one variable is associated with most of the variation in the other.

**Answer: A**

**293. The correlational fallacy refers to which of the following? [TY9.4]**

a. The idea that a correlation can be statistically significant without being psychologically meaningful.
b. The idea that a strong correlation between variables does not mean that one predicts the other.
c. The idea that a correlation between variables does not mean that one variable is responsible for variation in the other.
d. The idea that correlation does not justify prediction.
e. Both (a) and (c)

Answer: C

294. "Effects which reflect the impact of one independent variable averaged across all levels of other independent variables, rather than the impact of an interaction between two or more independent variables." What is is this a glossary definition of?

a. Main effects.
b. Average effects.
c. Significant effects.
d. Non-interaction effects.
e. Isolation effects.

Answer: A

295. A group of researchers conducts some research in which they identify a significant positive correlation (r = .42) between the number of children people have and their life satisfaction. Which of the following is it inappropriate to conclude from this research? [TY9.5]

a. That having children makes people more satisfied with their life.
b. That someone who has children is likely to be happier than someone who does not.
c. That the causes of life satisfaction are unclear.
d. That the consequences of having children are unclear.
e. That it is possible to predict someone's life happiness partly on the basis of the number of children they have.

Answer: A

296. Which of the following statements is true of the problem of restricted range? [TY9.6]

a. Restricted range can reduce the size of correlations.

b. Restricted range can lead to a violation of the assumption of bivariate normality.
c. Restricted range can produce regression to the mean.
d. All of the above.
e. Answers (a) and (b) only.

Answer: D

297. If an experimenter observes a correlation of −1 between two variables, which of the following is false? [TY9.7]

a. One variable is completely predictive of the other.
b. One variable is completely responsible for variation in the other.
a. Knowledge of the value of one variable allows one to know with certainty the value of the other.
a. A higher score on one variable is associated with a lower score on the other.
b. All the variation in one variable is associated with variation in the other.

Answer: B

298. If the correlation between people's wealth and a measure of their psychological well-being is .40, how much of the variation in their scores on the well-being measure will be associated with variation in their wealth? [TY9.8]

a. 60%
b. 40%
c. 16%
d. 4%
e. It is impossible to say without information about how psychological well-being is defined.

Answer: C

299. A researcher conducts some research in which they identify a significant positive correlation (r = .42) between the number of children a person has and their life satisfaction. Which of the following is it inappropriate to conclude from this research?

a. That having children makes people more satisfied with their life.
b. That someone who has children is likely to be more happy than someone who doesn't.
c. That the causes of life satisfaction are unclear.

d. That the consequences of having children are unclear.
e. That it is possible to predict someone's life happiness partly on the basis of the number of children they have.

Answer: A

300. A researcher conducts a survey with 221 participants who each complete 24 measures designed to assess the impact of social and psychological factors (such as demands, social support and role clarity) on stress in the workplace. As part of her analysis she investigates the correlations between pairs of these variables. How many degrees of freedom will her analysis have?

a. 221
b. 220
c. 219
d. 24
e. 23

Answer: C

301. "A graph plotting the scores on one variable against the scores on another." What type of graph is this a glossary definition of?

a. A line graph
b. A bar graph
c. A scatterplot
d. An angiogram
e. A scattergram

Answer: C

302. "A relationship between two variables that can be described by a straight line. The equation for such a line is y = a + bx, where b is the slope of the line (its gradient) and a is the y intercept (where it cuts the vertical axis)." Which type of relationship is this a glossary definition of?

a. A straight-line relationship
b. An a + b relationship
c. A bx relationship
d. A curvilinear relationship
e. A short-term relationship

Answer: A

303. "A measure of the degree of linear association between two variables." What is this a glossary definition of?

a. A correlation coefficient.
b. A covariance coefficient.
c. Covariance.
d. A product-moment coefficient.
e. A linear coefficient.

Answer: A

**304. "The amount of variation in one variable associated with variation in another variable (or variables). In the bivariate case this is given by $r^2$." What is this a glossary definition of?**

a. Variance.
b. Covariance.
c. Common variance.
d. Linear correlation.
e. Estimated variance.

**Answer: C**

**305. "A barrier to the correct interpretation of results that arises when the range of scores is limited because they are clustered in the region of the maximum scale value." What specific type of effect is this a glossary definition of?**

a. Restricted range effect.
b. Maximum value effect.
c. Floor effect.
d. Ceiling effect.
e. Doppler effect

**Answer: D**

**306. Which of the following is a pooled variance estimate that constitutes the denominator of an F-ratio? [TY10.1]**

a. The between-cells mean square ($MS_B$).
b. The mean of the sampling distribution.
c. The sum of the deviations from the grand mean.
d. The grand mean.
e. The within-cells mean square ($MS_W$).

**Answer: E**

**307. Which of the following statements is true? [TY10.2]**

a. In one-way ANOVA the total sum of squares comprises two main sources of variance: within-groups variance and between-groups variance. Each has the same number of degrees of freedom.
b. In one-way ANOVA the total sum of squares comprises two main sources of variance: within-groups variance and between-groups variance. Each has its own number of degrees of freedom.
c. In one-way ANOVA the total sum of squares comprises three main sources of variance: within-groups variance, between-groups

variance and error variance. Each has the same number of degrees of freedom.

d. In one-way ANOVA the total sum of squares comprises three main sources of variance: within-groups variance, between-groups variance and information variance. Each has the same number of degrees of freedom.

e. In one-way ANOVA the total sum of squares comprises three main sources of variance: within-groups variance, between-groups variance and information variance. Each has its own number of degrees of freedom.

Answer: B

308. What is the point of calculating the value of $\eta^2$ in relation to particular F- and p-values? [TY10.2]

a. $\eta^2$ is a hypothesis-testing measure that can tell us whether a particular F-value is significant.

b. $\eta^2$ is the square of $\alpha$ and can tell us whether a particular p-value is significant.

c. $\eta^2$ is a measure of effect size that can tell us whether a particular F-value is significant.

d. $\eta^2$ is a measure of effect size that can tell us whether a particular p-value is significant.

e. $\eta^2$ is a measure of effect size that can tell us how much variance a particular effect accounts for.

Answer: E

309. A researcher, Isobel, conducts one-way analysis of variance in which she compares the final marks of students who have studied psychology at one of five different institutions, A, B, C, D and E. The study looks at the marks of 100 students, 20 from each institution. On the basis of a given theory, the researcher plans to make four comparisons: between A and B, A and C, C and D, and C and E. Three other researchers make the following observations:

**X: 'If Isobel used an experimentwise alpha level of .01, a Bonferroni adjustment would mean that each of these tests had an alpha level of .0025.'**
**Y: 'If Isobel used an experimentwise alpha level of .05, a Bonferroni adjustment would mean that each of these tests had an alpha level of.0025.'**
**Z: 'If Isobel used an experimentwise alpha level of .05, a Bonferroni adjustment would mean that each of these tests had an alpha level of .0125.'**
**Who is correct? [TY10.4]**

a. **Only X.**
b. **Only Y.**
c. **Only Z.**
d. **X and Y.**
e. **X and Z.**

**Answer: E**

**310. An experimental psychologist conducts a study examining whether the speed with which two shapes can be identified as similar or different depends on whether the stimuli are (a) of equal or unequal size and (b) symmetrical or asymmetrical. The mean reaction times for the four cells of the design are as follows: equal symmetrical (M = 132 ms), unequal symmetrical (M = 148 ms), unequal asymmetrical (M = 142 ms), unequal asymmetrical (M = 182 ms). Which of the following is true? [TY10.5]**

a. **A line graph in which these data are plotted suggests that there might only be a main effect for size.**
b. **A line graph in which these data are plotted suggests that there might only be a main effect for symmetry.**
c. **A line graph in which these data are plotted suggests that there might only be a main effect for size and an interaction between size and symmetry.**
d. **A line graph in which these data are plotted suggests that there might only be a main effect for symmetry and an interaction between size and symmetry.**
e. **A line graph in which these data are plotted suggests that there might be main effects for size and symmetry and an interaction between size and symmetry.**

**Answer: E**

**311. Which of the following statements is false? [TY10.6]**

a. One difference between ANOVA and t-tests is that ANOVA allows researchers to compare responses of more than two groups.
b. One difference between ANOVA and t-tests is that ANOVA does not make assumptions about homogeneity, normality and independence.
c. One difference between ANOVA and t-tests is that ANOVA can be used to examine simultaneously the impact of more than one variable.
d. One difference between ANOVA and t-tests is that ANOVA is based on analysis of the ratios of variances.
e. One difference between ANOVA and t-tests is that ANOVA uses two separate degrees of freedom (one for between-cells variance, one for within-cells variance).

**Answer: B**

**312. A researcher conducts a study examining the impact of social support on depression in which he studies how four independent groups that each receive a different type of social support (financial, emotional, intellectual, none) react to a stressful experience. There are 20 people in each group. Which of the following statements is true? [TY10.7]**

a. There are 4 degrees of freedom for the between-cells variance.
b. There are 78 degrees of freedom for the within-cells variance.
c. If ANOVA yielded a between-groups F-value of −2.18 this would be significant with alpha set at .05.
d. If ANOVA yielded a between-groups F-value of 0.98 this would be significant with alpha set at .01.
e. None of the above statements is true.

**Answer: E**

**313. Which of the following statements about the F-distribution is false? [TY10.8]**

a. The distribution is asymmetrical.
b. The distribution is one-tailed.
c. Higher values of F are associated with a higher probability value.
d. The distribution is positively skewed.
e. If the amount of between-cells variance is equal to the amount of within-subjects variance, the value of F will be 1.00.

**Answer: C**

**314. The SPSS ANOVA output below is from a study in which participants were randomly assigned to one of four conditions in which they were given different instructions to encourage them to continue. Which of the following statements is true? There is no possibility at all that the results are due to chance.**

a. It would be useful to supplement the p-value with a measure of effect size.
b. With an alpha level of .01, ANOVA reveals a significant effect for Instruction.
c. As groups are randomly assigned, we need to compute a z-score in order to gauge the size of these effects relative to chance.
d. Both (a) and (b).

**Answer: B**

**315. The SPSS ANOVA output below is from a study in which participants were randomly assigned to one of four conditions in which they were given different instructions to encourage them to continue. Which of the following statements is true?**

a. ANOVA shows that there was no effect for Instruction.
b. With an alpha level of .05, ANOVA reveals a significant effect for the Instruction.
c. With an alpha level of .01, ANOVA reveals a significant effect for Instruction.
d. With an alpha level of .05, ANOVA reveals a significant effect for Intercept.

e. **With an alpha level of .01, ANOVA reveals a significant effect for Intercept.**

**Answer: B**

**316. "A hypothetical model in which mean responses differ across the conditions of an experimental design. This represents an alternative to the null hypothesis that the mean response is the same in all conditions." What is this a glossary definition of?**

a. **Hypothetical model.**
b. **Hypothetical difference model.**
c. **Difference model.**
d. **Effects model.**
e. **Experimental model.**

**Answer: D**